

From the riverhead to Balsas city, the river is relatively narrow. The portion of the channel that allows the navigation of vessels is between the cities of Balsas and Urucui, and its overall length is approximately 255 kilometers. The river bed gradient is approximately 1/3,100.

Table 3.1.1 Extreme Water Depth of the Basin

River	Station Name	Year	Rainy Season	Dry Season	High W.L. (m)	Low W.L. (m)
Parnaíba	Volta do Machado	1979	Jan. to May	July to Oct.	4.96	1.42
		1983	Feb. to April	July to Oct.	4.14	1.46
Parnaíba	Alto Parnaíba	1973	Dec. to April	June to Sep.	5.83	3.39
		1983	Dec. to March	July to Oct.	6.30	3.50
Parnaíba	Ribeiro Goncalves	1973	Dec. to April	June to Sep.	4.28	2.46
		1983	Dec. to March	July to Oct.	5.38	2.67
Parnaíba	Paracati Fazenda	1974	Jan. to May	July to Oct.	4.42	1.92
		1983	Jan. to April	July to Nov.	4.90	1.93
Parnaíba	Floriano	1982	Jan. to April	July to Nov.	6.82	0.50
Parnaíba	Teresina	1964	Jan. to April	July to Sep.	4.70	0.50
		1983	Dec. to April	Aug. to Oct.	5.98	2.19
Balsas	Sao Felix	1974	Jan. to April	July to Oct.	6.82	1.30
		1983	Dec. to April	July to Oct.	4.18	1.09
Balsas	Balsas	1974	Dec. to April	July to Sep.	3.90	2.34
		1983	Dec. to April	July to Sep.	5.10	2.48

Source: Ministerio dos Transport

3.2 Water Depth and Discharge Volumes at Monitoring Stations

(1) Location and Elevation

There are nine water level monitoring stations along the Parnaíba river. Water level monitoring of these stations is carried out by Companhia Hidro Eletrica do Sao Francisco (CHESF). Datum altitudes of these stations were measured using the global positioning system (GPS) during the Phase I study period by the JICA Study Team. Furthermore, two additional water level monitoring stations were newly constructed at Parnaíba and Amarante. Fig. 3.2.1 shows the location of the water level monitoring stations.

Table 3.2.1 shows the datum altitudes (zero gauging level) of the monitoring stations and Fig. 3.2.2 shows the longitudinal cross section of the river.

Table 3.2.1 Zero Gauging Level for 11 Monitoring Stations

Station Name	Survey Date	Zero Gauging Level (E.L. m)	Water Level in Altitude (m)
1. Parnaíba	'93. 1.22	0.2	
2. Luzilandia	'93. 1.22	13.6	16.0
3. Uniao	'93. 1.16	40.1	43.4
4. Teresina	'93. 1.13	52.4	55.8
5. Fazenda Veneza	'93. 1.14	62.7	67.5
6. Amarante	'93. 1.28	86.0	86.4
7. Floriano	'93. 1.29	97.1	100.9
8. Guadalupe	'93. 2.1	122.1	113.5
9. Urucui	'93. 2.2	157.1	159.4
10. Ribeiro Goncalves	'93. 2.3	186.7	189.7
11. Santa Filomena	'93. 2.5	263.8	267.6

Source: JICA Study Team

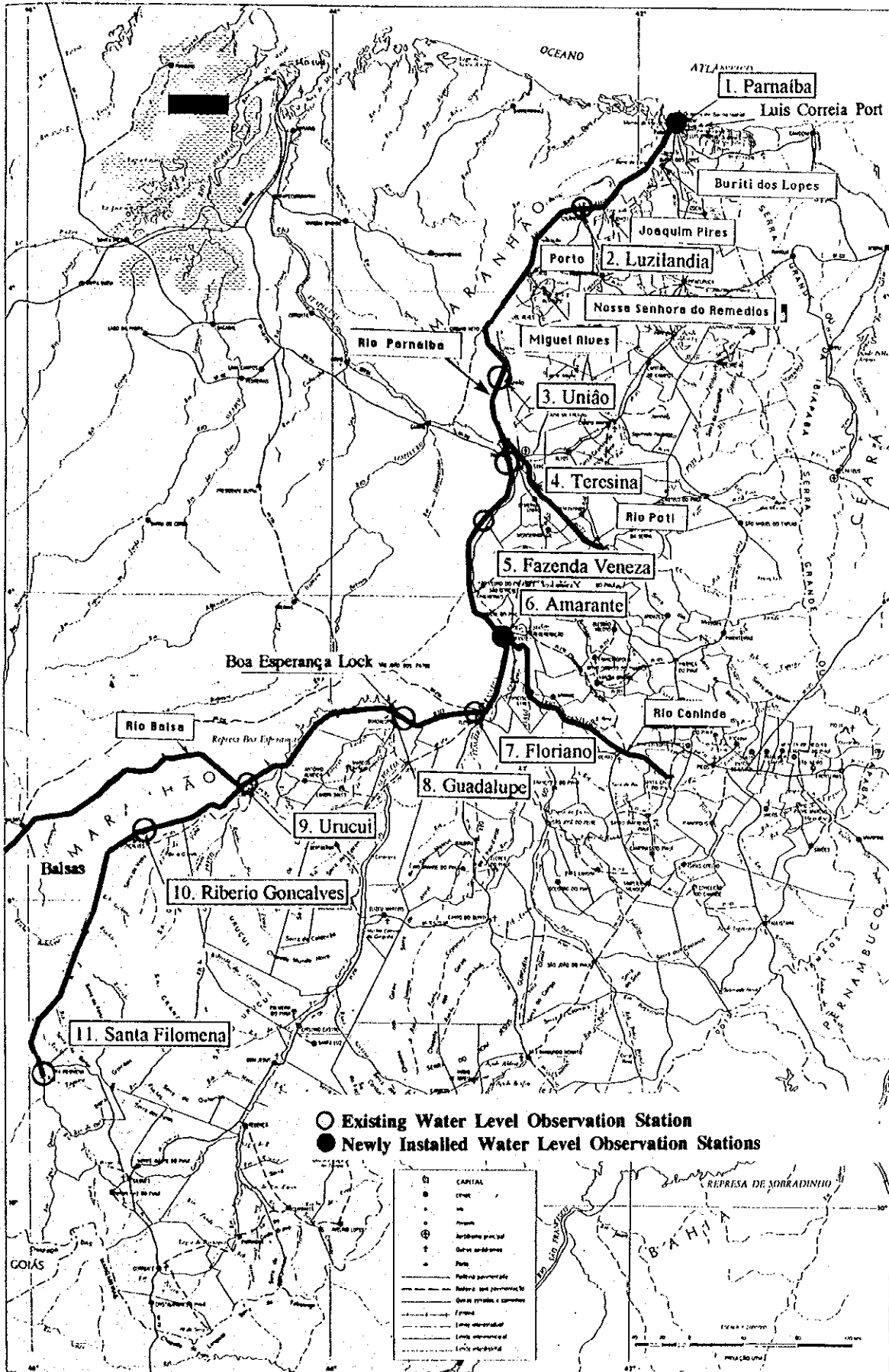


Fig. 3.2.1 Water Level Monitoring Stations

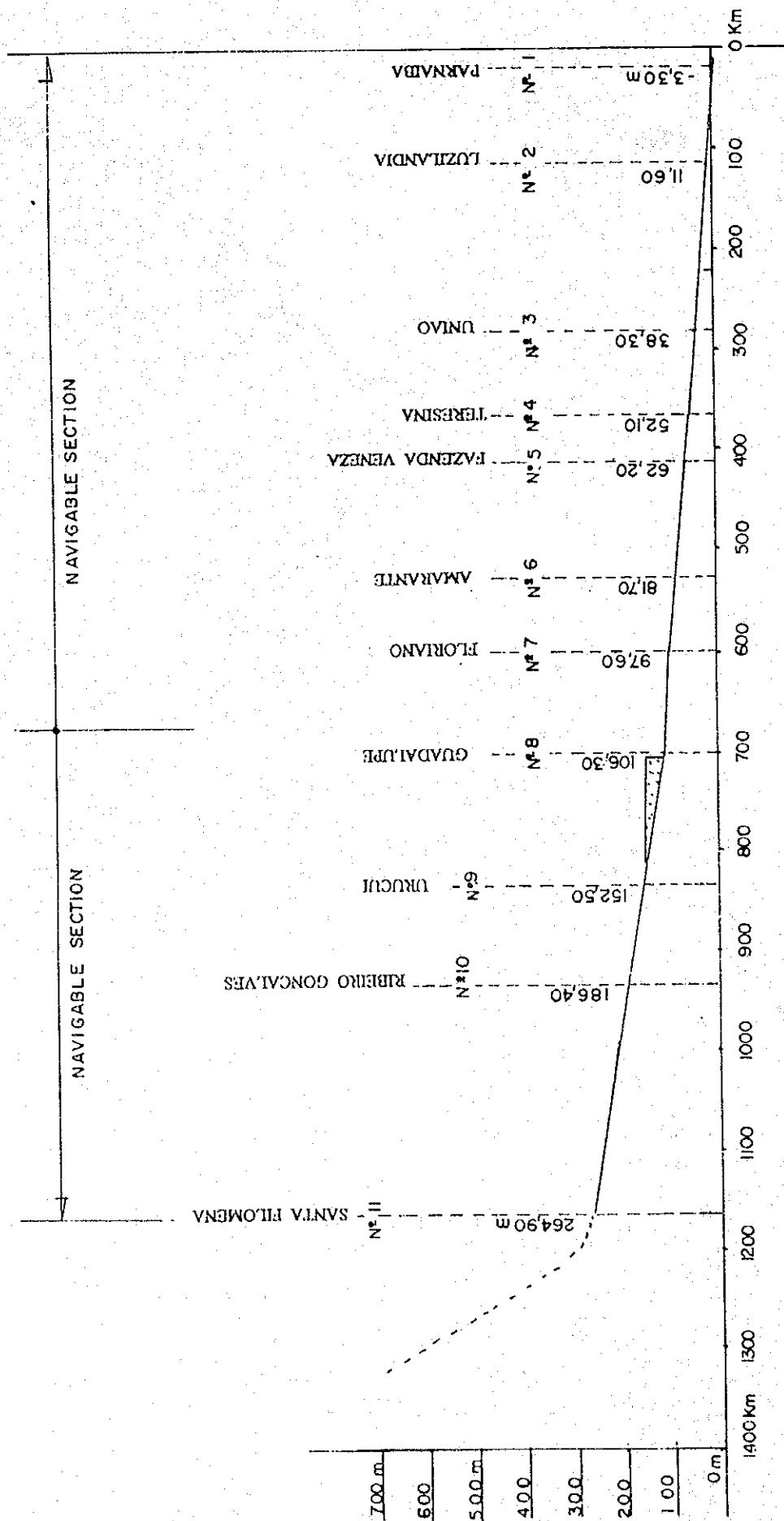


Fig. 3.2.2 Longitudinal Cross Section of the Paranaíba River

(2) Water Depth and Discharge Volume

The water depth records at 11 monitoring stations in 1993 are presented in Tables 3.2.2 and 3.2.3. The monthly maximum and minimum water depth at Amarante and Parnaíba in Table 3.2.2 was recorded by the JICA Study Team and the water depth at the other 9 stations in Table 3.2.3 was recorded by CHESF.

Also Figs. 3.2.3 to 3.2.11 show the average and minimum water depth at 9 monitoring stations throughout the year. These figures are obtained based on the last 10 to 20 years' data by CHESF.

Fig. 3.2.12 shows the average discharge volume at 6 monitoring stations obtained from the water level records and the rating curves by CHESF.

From these tables and figures, the particulars of the Parnaíba river are as follows:

- The rainy season is from November to April and the dry season is from May to October.
- The water depth at Guadalupe is affected by the water volume discharged from the power station at Boa Esperança Dam and the water depth below the Dam is almost constant through the year.
- The water depth difference between the dry and rainy seasons is about 1.0 meter for the upstream portion (Santa Filomena and Riberio Gonçalves), 1.5 to 2.0 meters for the midstream portion (Floriano, Fazenda Veneza, Teresina, and União), and 2.0 to 3.0 meters for the downstream portion (Luzilandia).
- Water depths below 1.0 meter are recorded at Fazenda Veneza and Luzilandia during the dry seasons.
- An average discharge volume during the dry season is about 80 to 190 m³/s for the upstream portion (Santa Filomena and Ribeiro Goncalves), 300 to 400 m³/s for the midstream portion (Floriano, Fazenda Veneza and Teresina), and 400 to 500 m³/s for the downstream portion (Luzilandia).

Table 3.2.2 Monthly Water Depth at Amarante and Parnaíba in 1993

Month	Amarante				Parnaíba			
	Max. EL. (m)	Min. EL. (m)	Max. Depth. (m)	Min. Depth (m)	Max. EL. (m)	Min. EL. (m)	Max. Depth (m)	Min. Depth (m)
Jan.	86.37	86.25	4.67	4.55				
Feb.	88.41	85.89	6.71	4.19	2.01	0.56	7.31	5.86
Mar.	87.03	85.80	5.33	4.10	2.06	0.71	7.36	6.01
Apr.	87.65	85.82	5.95	4.11	2.51	0.91	7.81	6.21
May	86.37	85.48	4.67	3.78	2.21	0.56	7.51	5.86
Jun.	85.89	85.69	4.19	3.99	1.86	0.51	7.16	5.81
Jul.	85.89	85.71	4.19	4.01	2.26	0.34	7.56	5.64
Aug.	86.85	85.73	5.15	4.03	2.09	0.51	7.39	5.81
Sep.	85.95	85.76	4.25	4.06	2.01	0.46	7.31	5.76
Oct.	86.16	85.77	4.46	4.07	2.26	0.61	7.56	5.91
Nov.	86.51	85.78	4.80	4.08	2.46	0.66	7.76	5.96
Dec.	87.20	85.81	5.50	4.11	2.11	0.61	7.41	5.91
Average	86.69	85.79	4.99	4.09	2.17	0.59	7.47	5.89

Note : Max. and Min. depth means that the water depth at the deepest river bed point.

Source : JICA Study Team

Table 3.2.3 Water Depth at 9 Monitoring Stations in 1993

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Santa Filomena (Alto Parnaiba)	Max.	4.04	4.72	4.72	5.06	4.46	3.55	3.49	3.44	3.83	3.94	4.52
	Ave.	3.79	4.11	3.89	3.98	3.72	3.51	3.46	3.42	3.48	3.56	3.91
	Min.	3.60	3.60	3.66	3.65	3.56	3.49	3.44	3.39	3.38	3.44	3.56
Riberio Goncalves	Max.	3.40	4.31	3.59	3.87	3.71	2.78	2.70	2.63	3.20	3.17	3.79
	Ave.	3.17	3.52	3.28	3.30	3.02	2.74	2.66	2.61	2.66	2.79	3.22
	Min.	2.94	2.98	3.06	2.94	2.82	2.70	2.63	2.58	2.54	2.65	2.80
Urucui (Benedito Leite)	Max.	7.73	8.40	8.32	8.55	8.75	8.52	8.24	7.78	7.18	7.11	7.90
	Ave.	7.20	7.60	8.01	8.37	8.58	8.38	8.03	7.50	6.96	6.79	7.16
	Min.	6.81	6.81	7.72	8.28	8.52	8.25	7.80	7.19	6.80	6.57	6.77
Guadalupe (Boa Esperanca)	Max.	9.44	10.46	7.82	8.75	7.48	7.50	7.19	9.76	7.55	7.67	8.98
	Ave.	8.49	8.29	7.12	7.64	7.17	7.16	7.14	7.25	7.16	7.13	8.17
	Min.	8.05	7.12	7.03	7.04	7.13	7.06	7.03	7.05	7.06	7.06	7.08
Floriano	Max.	4.85	5.63	3.81	4.46	3.63	3.41	3.40	3.87	3.52	3.72	4.53
	Ave.	4.21	4.18	3.59	3.75	3.39	3.31	3.32	3.37	3.38	3.47	3.99
	Min.	3.72	3.33	3.46	3.43	3.31	3.20	3.24	3.25	3.29	3.22	3.32
Fazenda Veneza (Parnarama)	Max.	3.12	3.65	2.90	2.94	2.08	1.61	1.58	2.25	1.70	1.82	2.73
	Ave.	2.44	2.30	1.97	2.05	1.64	1.52	1.53	1.58	1.58	1.66	2.20
	Min.	1.84	1.60	1.72	1.63	1.52	1.48	1.45	1.48	1.49	1.52	1.55
Teresina	Max.	3.85	4.34	3.50	3.67	3.14	2.53	2.40	2.60	2.54	2.67	3.53
	Ave.	3.30	3.19	2.85	2.95	2.51	2.41	2.36	2.36	2.38	2.50	3.06
	Min.	2.63	2.50	2.58	2.50	2.30	2.35	2.23	2.30	2.33	2.38	2.34
Uniao	Max.	3.51	4.23	3.71	3.64	3.20	2.34	2.30	2.66	2.43	2.49	3.23
	Ave.	3.01	2.95	2.73	2.89	2.46	2.27	2.25	2.27	2.27	2.34	2.79
	Min.	2.52	2.31	2.44	2.46	2.31	2.23	2.19	2.19	2.22	2.28	2.27
Luzilandia (Santa Quitéria)	Max.	2.64	3.19	2.95	2.76	2.60	1.28	1.18	1.20	1.52	1.39	2.34
	Ave.	2.19	1.99	1.94	2.11	1.62	1.20	1.15	1.13	1.18	1.25	1.73
	Min.	1.70	1.38	1.55	1.56	1.30	1.10	1.08	1.08	1.11	1.13	1.17

Source: CHESF

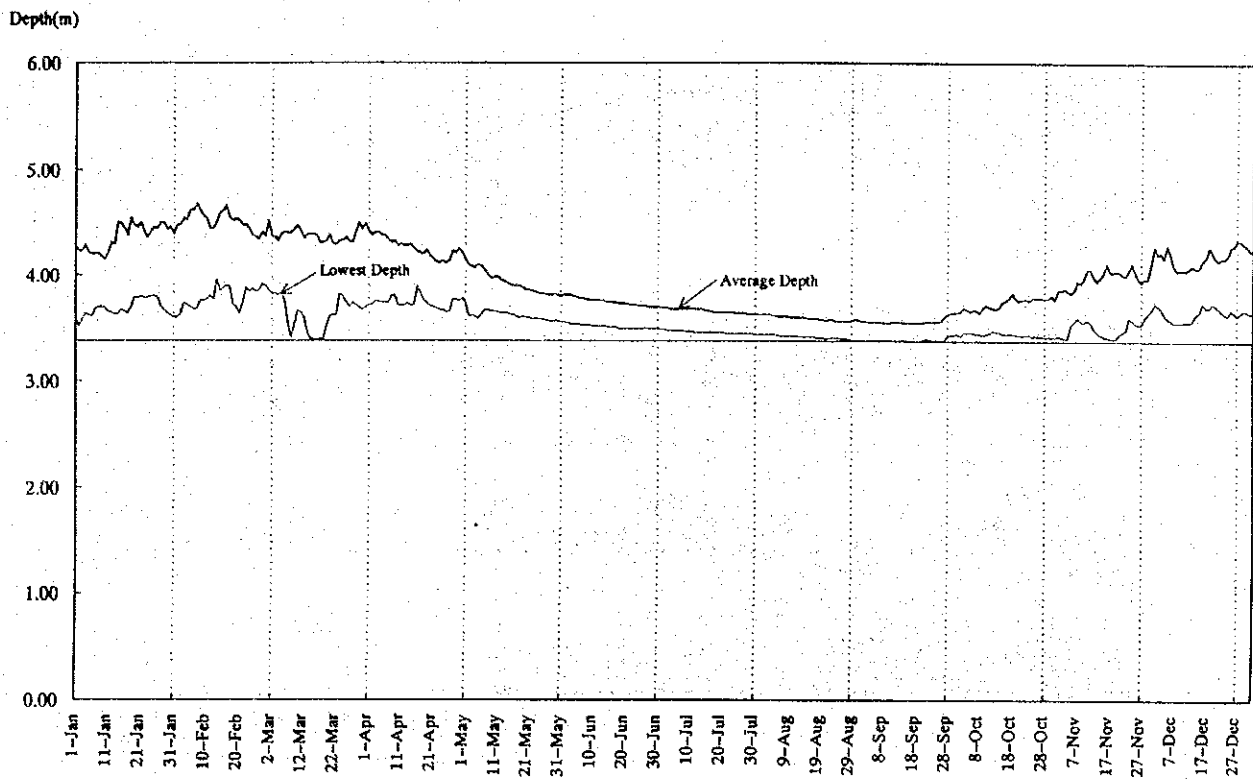


Fig. 3.2.3 Average and Minimum Water Depth at Santa Filomena (1970 - 1993)
 Source : JICA Study Team

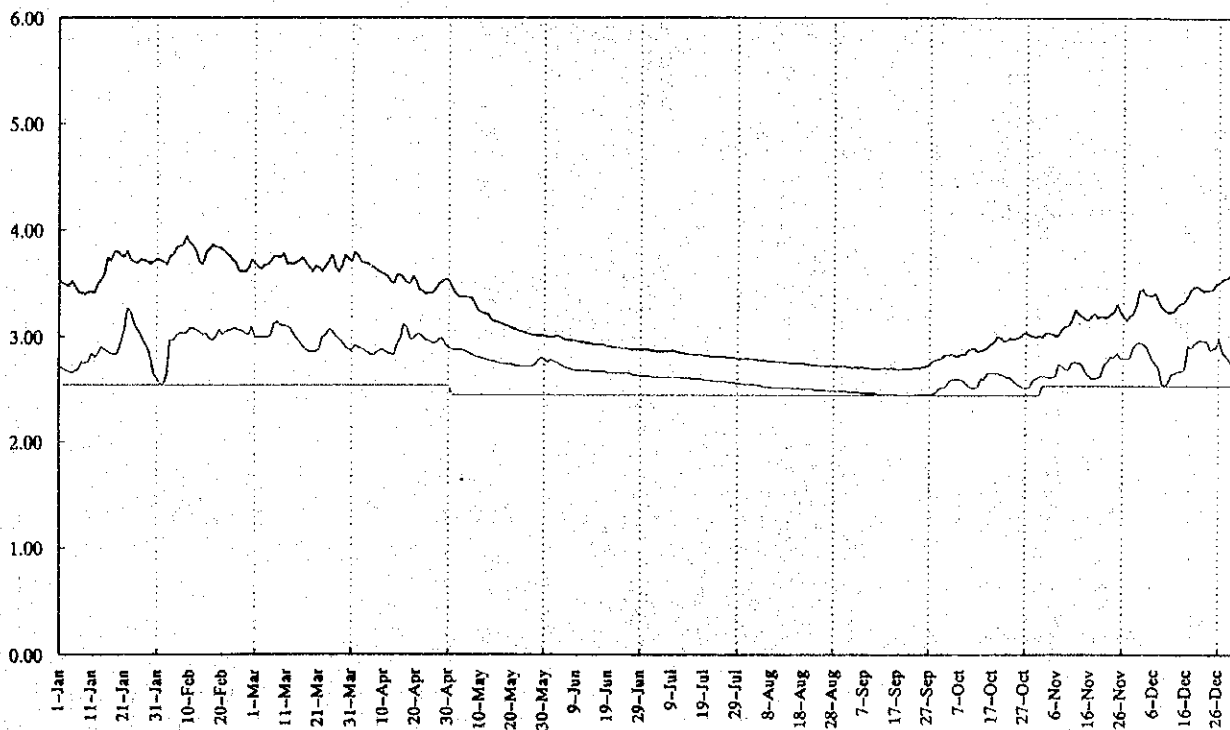


Fig. 3.2.4 Average and Minimum Water Depth at Riberio Goncalves (1970 - 1993)
 Source : JICA Study Team

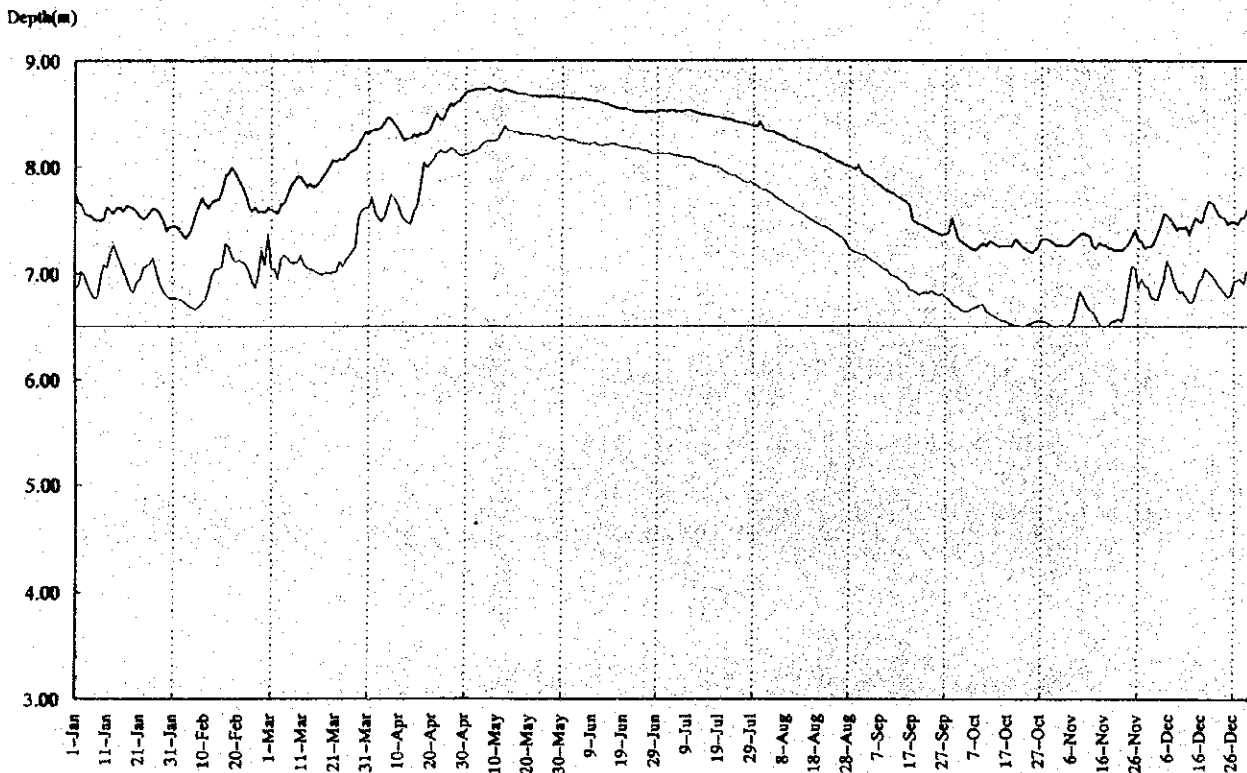


Fig. 3.2.5 Average and Minimum Water Depth at Urucui (1986 - 1993)
Source : JICA Study Team

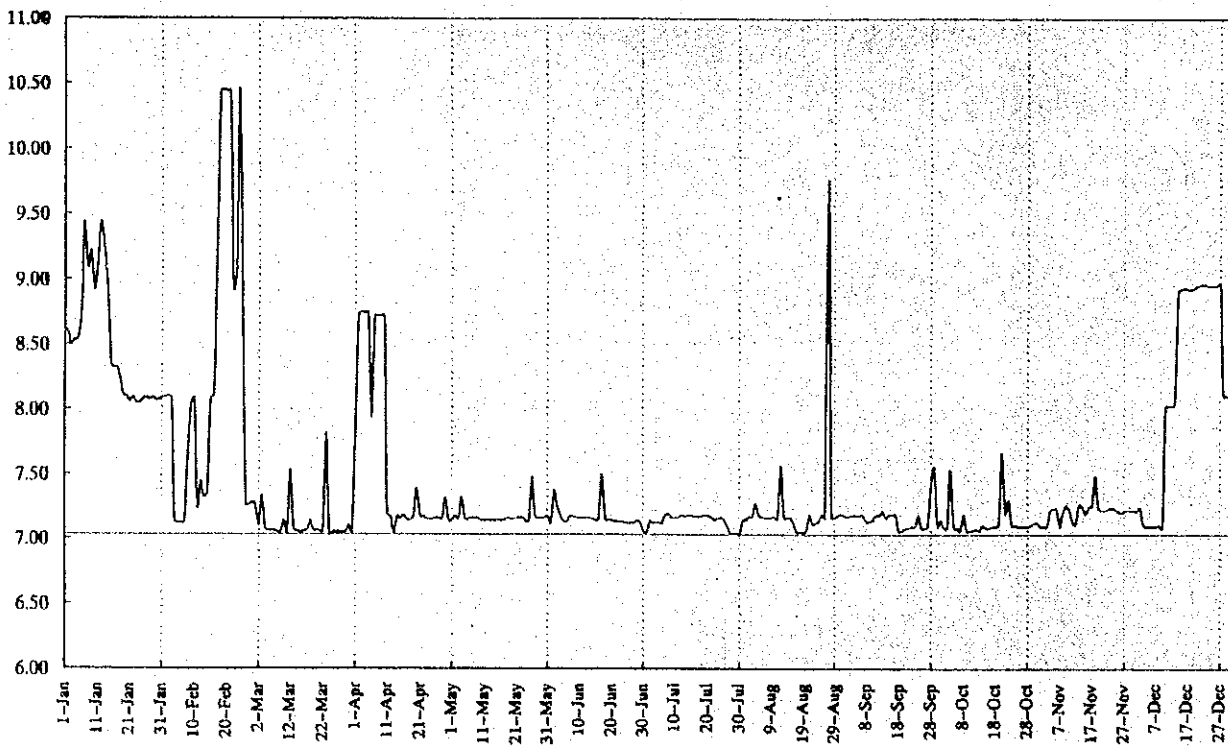


Fig. 3.2.6 Average and Minimum Water Depth at Guadalupe (1993)
Source : JICA Study Team

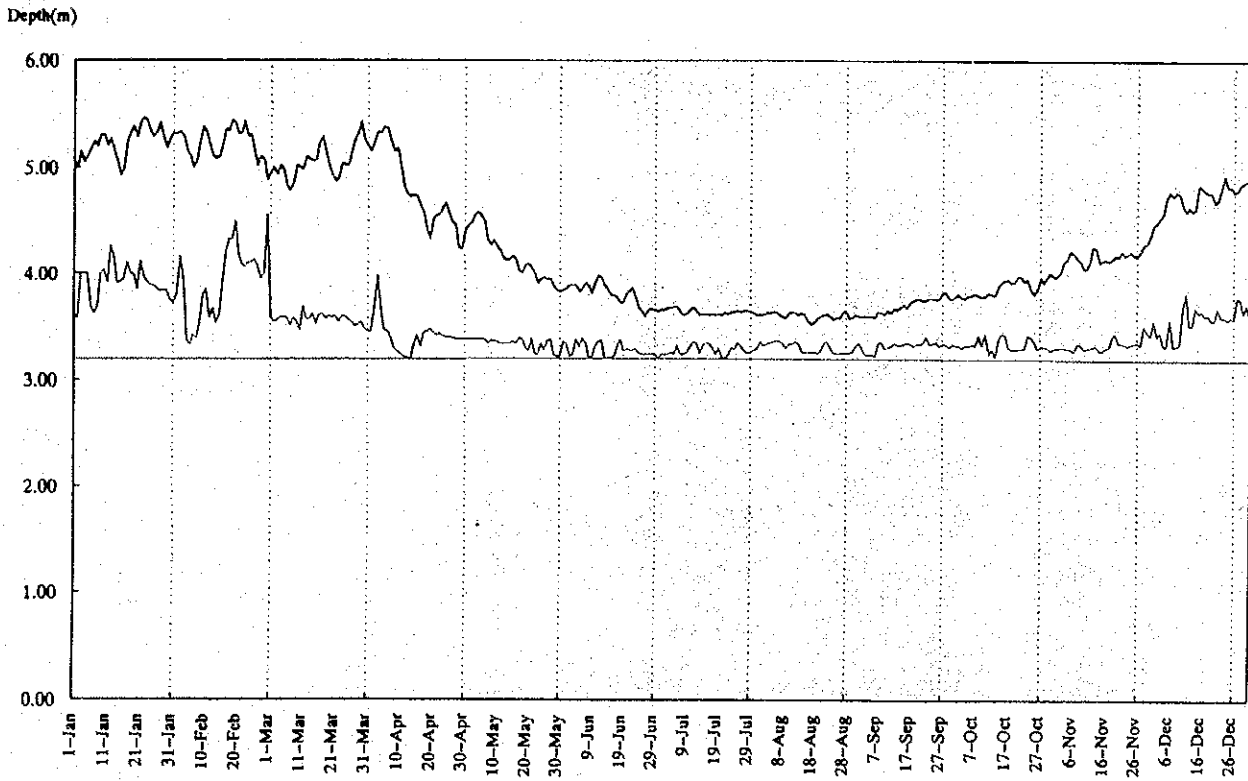


Fig. 3.2.7 Average and Minimum Water Depth at Floriano (1981 - 1993)
Source : JICA Study Team

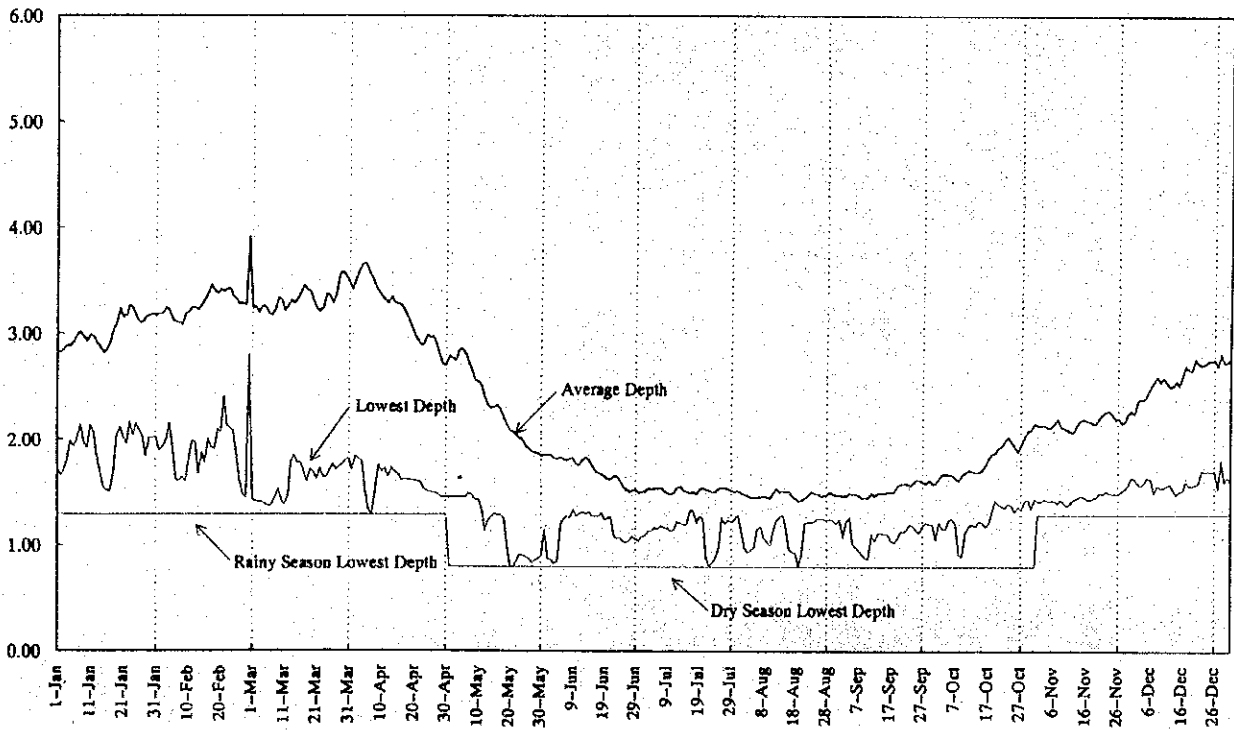


Fig. 3.2.8 Average and Minimum Water Depth at Fazenda Veneza (1973 - 1993)
Source : JICA Study Team

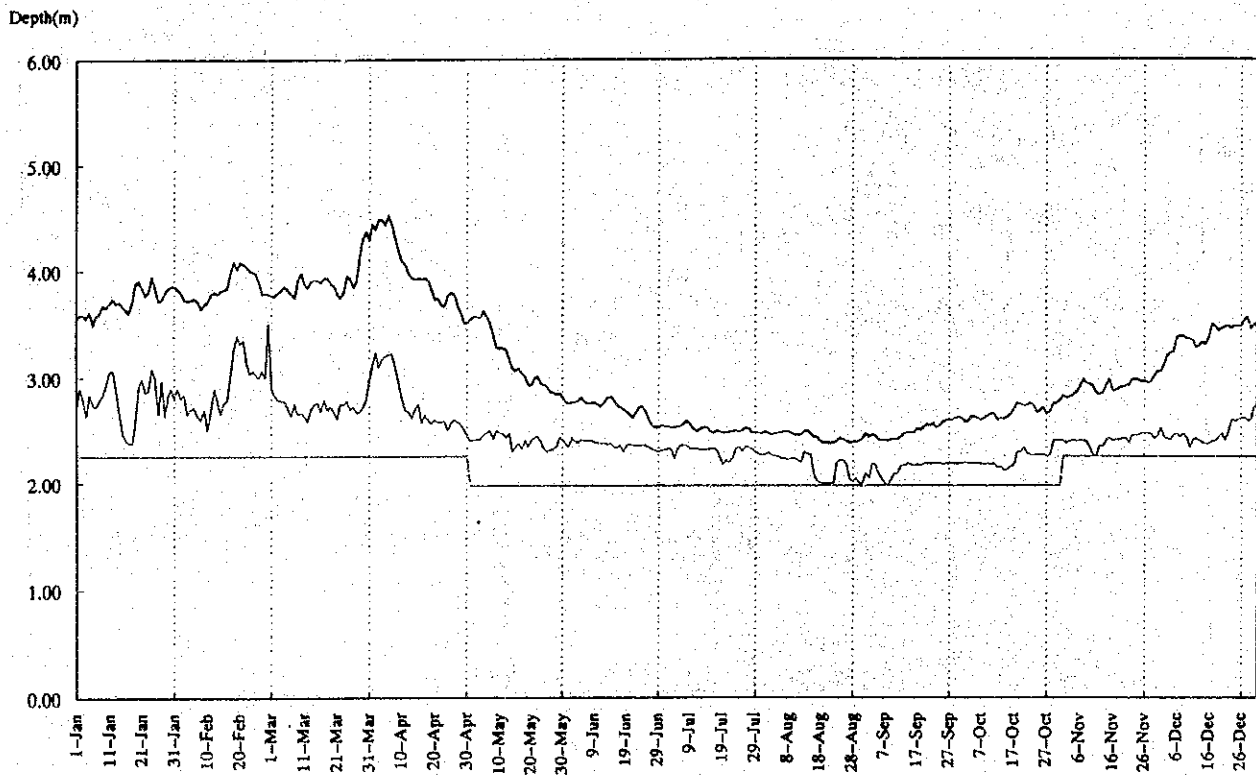


Fig. 3.2.9 Average and Minimum Water Depth at Teresina (1981 - 1993)

Source : JICA Study Team

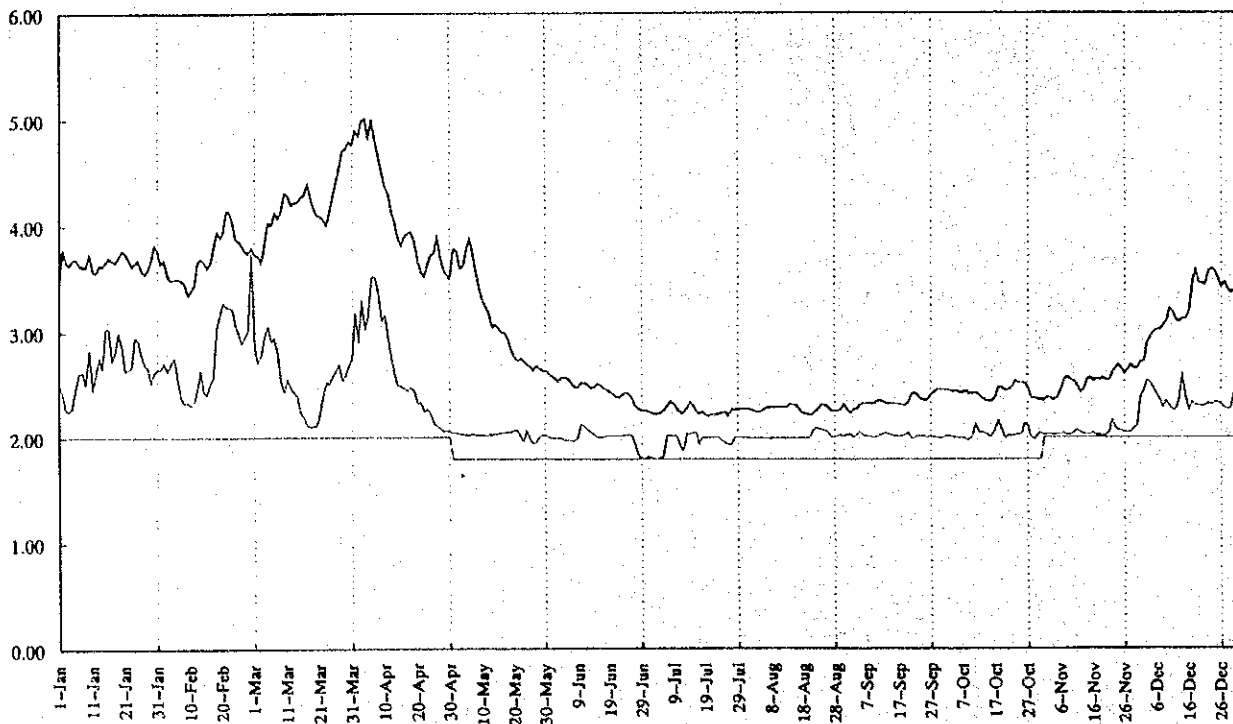


Fig. 3.2.10 Average and Minimum Water Depth at União (1986 - 1993)

Source : JICA Study Team

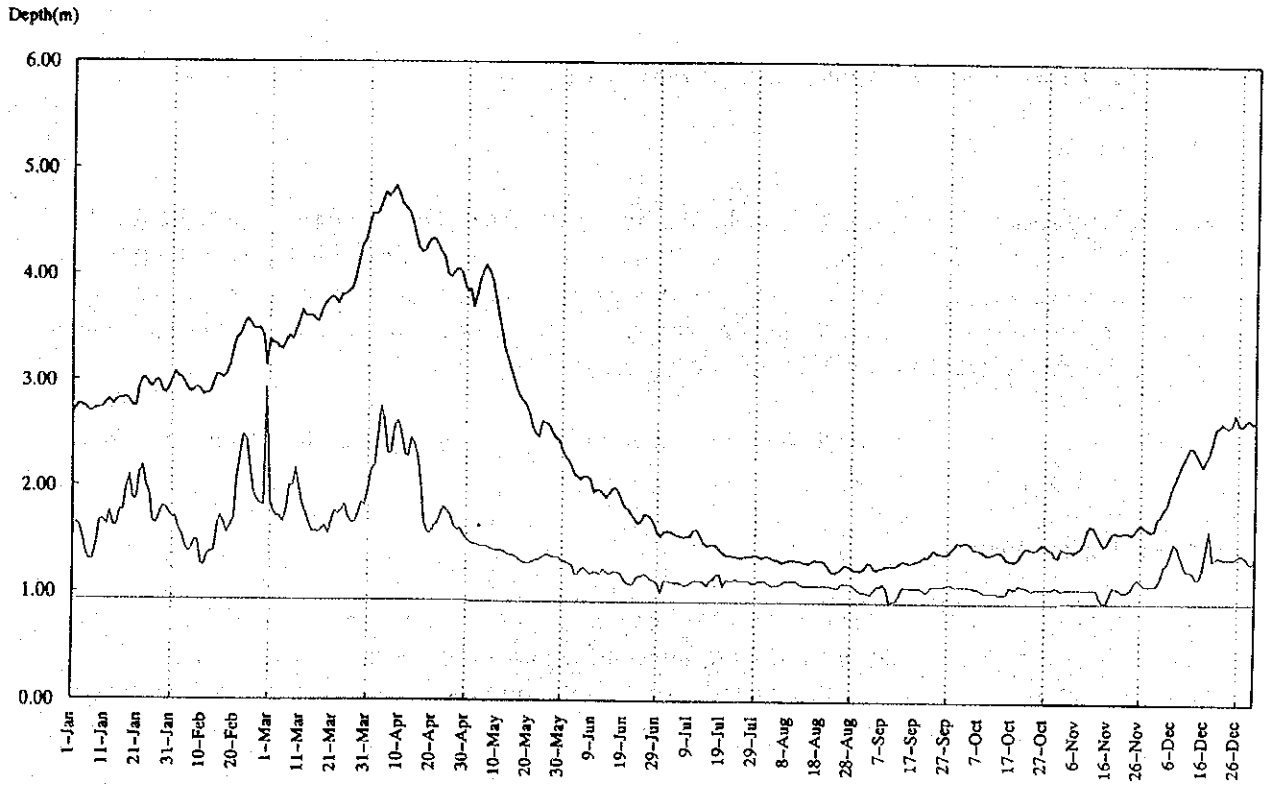


Fig. 3.2.11 Average and Minimum Water Depth at Luzilandia (1983 - 1993)
Source : JICA Study Team

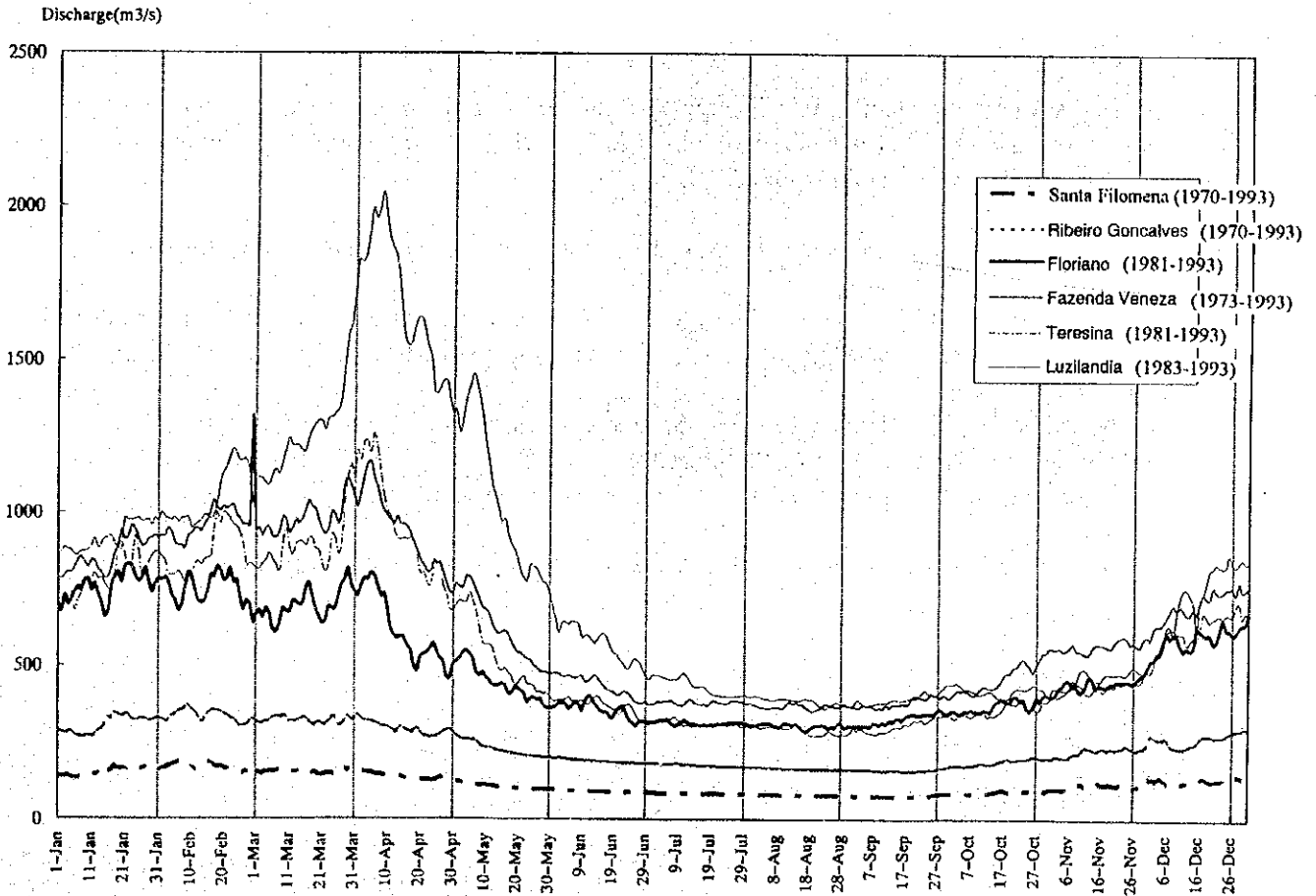


Fig. 3.2.12 Discharge Volume at Monitoring Stations Source : JICA Study Team

3.3 Water Depth in the Topographic Survey Area

(1) Location

In order to recognize the cross sectional condition of the Parnaiba river basin especially for the sand bar areas where the water depth is expected to be too shallow for river navigation, a topographic survey and river flow observations were conducted at twenty one (21) locations along the Parnaiba river basin during the dry and rainy seasons in 1993 and 1994 (see Fig. 3.3.1 for the location of the topographic survey area).

These areas were pre-selected on consideration of the survey results from the JICA Preparatory Study Team in July 1992.

(2) Survey Records

The topographic survey was carried out by using an electric distance meter, echo sounder and transit, etc.. The positioning of the topographic survey area are checked by GPS. Water level altitude of each survey area was estimated based on the observed records at the existing water level monitoring stations along the Parnaiba river.

Tables 3.3.1 shows the summary of river width and water depth at each survey area (see Appendix 2 for the topographic survey results). Table 3.3.2 shows the river flow observation results. The observed river flow of each survey area ranges between 0.78 and 1.80 m/sec.

(3) Average Water Depth at Survey Area

The average water depth in the survey area is estimated based on the results of the cross sectional topographic survey and the average discharge volume at the water level monitoring stations. The results are shown in Appendix 2.

From these figures, the average water depth in the survey area will be summarized as follows:

- The water depth in Miguel Alves is the shallowest among the survey areas. The estimated average water depth during dry seasons is 1.6 meters and about 3.1 meters for rainy seasons.
- The water depth difference between dry and rainy seasons is about 0.5 meters for the upstream portion, and 1.1 to 3.0 meters for the midstream and downstream portions.
- The river flow ranges from 0.70 to 1.30 m/s for dry seasons, and 0.80 to 1.80 m/s for rainy seasons.
- The river width at Guadalupe is the narrowest. The minimum width is about 36 meters.

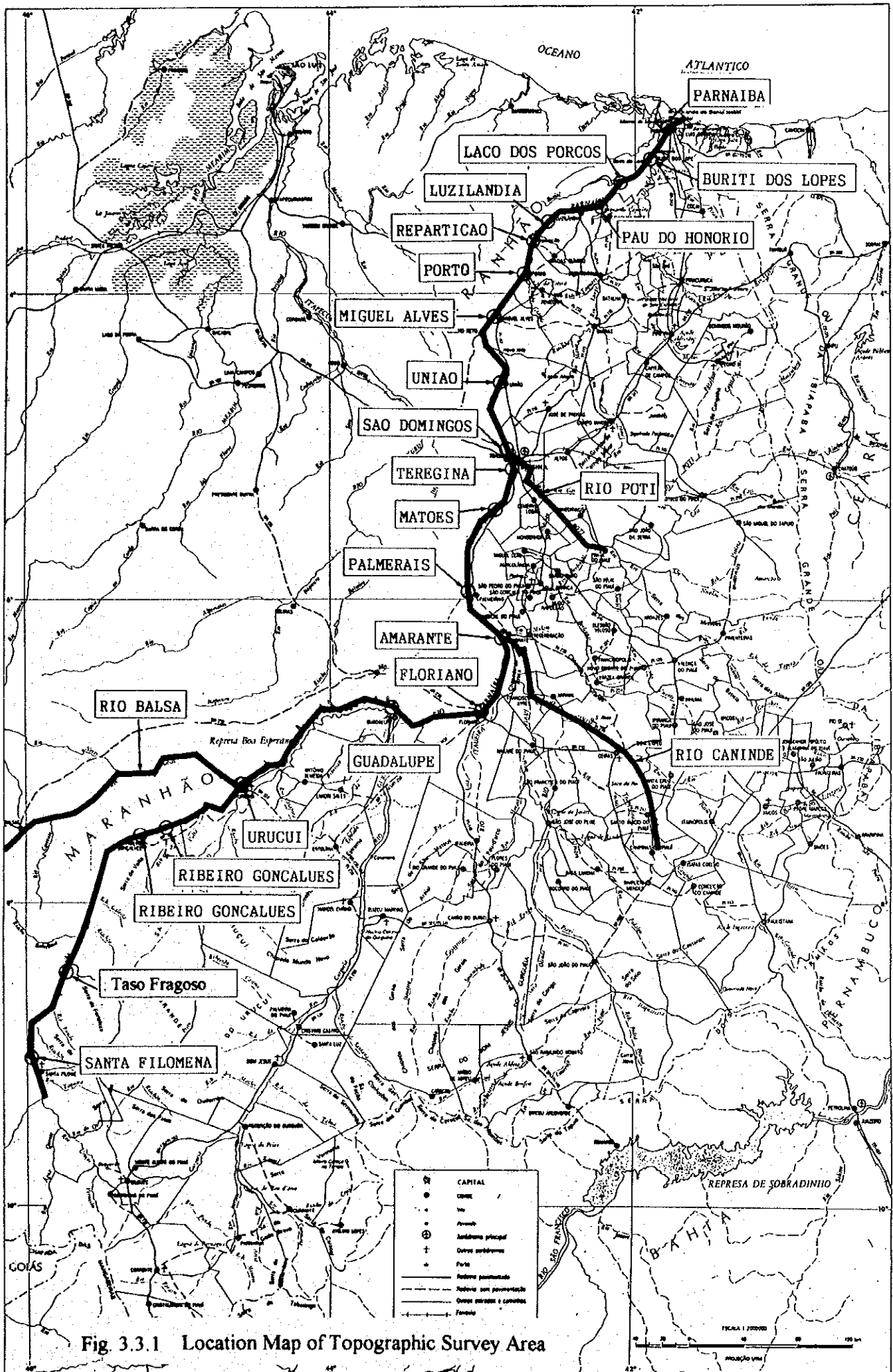


Fig. 3.3.1 Location Map of Topographic Survey Area

Table 3.3.1 Summary of the Topographic Survey

No.	Name	Location	Water Level (EL. m)	River Width (m)	Water Depth (m)
1	Parnaíba	S 2°53'43", W 41°46'36"	1.85 (0.64)	64 - 114 (48 - 98)	4.0 - 8.3 (2.7 - 7.0)
2	Buriti dos Lopes	S 3°08'53", W 41°55'39"	7.2 (5.50)	412 - 706 (285 - 690)	4.0 - 5.5 (3.1 - 4.5)
3	Lago dos Porcos	S 3°05'45", W 42°07'05"	11.6 (10.50)	475 - 495 (472 - 490)	3.5 - 4.4 (1.5 - 2.9)
4	Magaidas de Aimeida (Pau do Honorio)	S 3°24'10", W 42°12'10"	15.1 (14.0)	552 - 560 (52 - 539)	5.8 - 7.0 (3.1 - 5.5)
5	Santa Quiteria do Marabhao (Luzilandia)	S 3°32'02", W 42°32'49"	22.80 (21.7)	472 - 516 (511 - 637)	5.0 - 5.1 (2.4 - 4.0)
6	Brejo (Repaticao)	S 3°40'55", W 42°40'55"	26.60 (25.40)	272 - 280 (255 - 258)	4.0 - 4.6 (2.9 - 3.4)
7	Porto	S 3°53'39", W 42°43'15"	29.70 (28.50)	370 - 400 (350 - 393)	4.0 - 4.5 (2.9 - 3.2)
8	Miguel Alves	S 4°09'28", W 42°53'39"	34.40 (32.90)	645 - 693 (642 - 688)	3.3 - 5.3 (1.0 - 2.0)
9	União	S 4°35'05", W 42°52'17"	44.10 (42.5)	340 - 600 (330 - 516)	3.9 - 5.0 (1.5 - 2.3)
10	Sao Domingos	S 4°57'52", W 42°51'38"	52.40 (51.2)	500 - 555 (95 - 200)	6.2 - 7.0 (5.3 - 6.3)
11	Teresina	S 5°06'21", W 42°48'53"	56.00 (54.79)	370 - 420 (363 - 412)	2.5 - 4.2 (1.9 - 2.8)
12	Parnarama (Matoes)	S 5°40'58", W 43°05'11"	71.30 (70.09)	252 - 288 (223 - 246)	4.0 - 5.1 (2.5 - 3.8)
13	Palmerais	S 5°58'47", W 43°03'45"	78.10 (76.90)	212 - 244 (203 - 239)	4.2 - 6.6 (5.3 - 3.4)
14	Amarante	S 6°14'45", W 42°51'19"	87.34 (85.80)	284 - 328 (172 - 217)	4.2 - 6.0 (2.0 - 4.4)
15	Floriano	S 6°45'38", W 43°00'52"	101.70 (100.20)	216 - 224 (200 - 208)	4.0 - 4.3 (2.5 - 2.9)
16	Guadalupe	S 6°46'21", W 43°32'43"	115.22 (113.34)	76 - 104 (36 - 84)	11.1 - 11.6 (9.2 - 9.8)
17	Urucui	S 7°13'35", W 44°33'32"	160.10 (160.40)	116 - 228 (122 - 231)	3.3 - 5.2 (3.5 - 5.6)
18	Ribeiro Gonçalves 1	S 7°33'05", W 45°14'15"	190.00 (189.32)	66 - 145 (55 - 140)	3.0 - 5.6 (2.5 - 5.0)
19	Ribeiro Gonçalves 2	S 7°33'16", W 45°14'36"	190.06 (189.32)	105 - 190 (107 - 190)	2.6 - 4.5 (1.7 - 3.8)
20	Taso Fragoso (Santa Filomena 1)	S 8°28'16", W 45°44'33"	228.85 (228.20)	79 - 88 (70 - 83)	2.5 - 3.0 (1.8 - 2.4)
21	Santa Filomena 2	S 9°06'46", W 45°55'30"	267.85 (267.23)	88 - 92 (88 - 91)	2.0 - 2.2 (1.4 - 1.5)

Source: JICA Study Team

Note that the numbers in parenthesis show the survey results of the Phase II study, during dry seasons.

Table 3.3.2 Results of the River Flow Observations

No.	Name	Location	Survey Date	River Flow (m/s)
1	Parnaíba	S 2°53'43", W 41°46'36"	Jan. 29, 94	0.78 (1.28)
2	Buriti dos Lopes	S 3°08'53", W 41°55'39"	Jan. 30, 94	0.89 - 1.12 (1.03)
3	Lago dos Porcos	S 3°05'45", W 42°07'05"	Feb. 1, 94	0.85 - 0.93 (0.91)
4	Magaidas de Almeida (Pau do Honorio)	S 3°24'10", W 42°12'10"	Jan. 31, 94	0.87 - 0.91 (0.89)
5	Santa Quitéria do Marabão (Luzilandia)	S 3°32'02", W 42°32'49"	Feb. 2, 94	1.08 (0.72)
6	Brejo (Reparticao)	S 3°40'55", W 42°40'55"	Feb. 3, 94	0.91 - 1.25 (0.69)
7	Porto	S 3°53'39", W 42°43'15"	Feb. 4, 94	0.90 - 1.11 (1.08)
8	Miguel Alves	S 4°09'28", W 42°53'39"	Jan. 23, 94	0.90 - 0.94 (0.86)
9	União	S 4°35'05", W 42°52'17"	Jan. 22, 94	0.88 - 1.62 (0.90)
10	Sao Domingos	S 4°57'52", W 42°51'38"	Jan. 20, 94	1.44 - 1.46 (0.71 - 1.43)
11	Teresina	S 5°06'21", W 42°48'53"	Jan. 19, 94	0.91 - 1.12 (1.03)
12	Pamarama (Matoes)	S 5°40'58", W 43°05'11"	Jan. 18, 94	0.91 - 1.33 (0.99)
13	Palmerais	S 5°58'47", W 43°03'45"	Jan. 21, 94	0.90 - 1.41 (0.54 - 1.09)
14	Amarante	S 6°14'45", W 42°51'19"	Jan. 26, 94	0.91 (1.19)
15	Floriano	S 6°45'38", W 43°00'52"	Jan. 27, 94	0.82 - 0.95 (0.93 - 1.03)
16	Guadalupe	S 6°46'21", W 43°32'43"	Feb. 23, 94	1.44 - 1.46 (1.08)
17	Urucui	S 7°13'35", W 44°33'32"	Feb. 22, 94	P:1.26, B:1.17 (P:1.77, B:0.72)
18	Ribeiro Gonçalves 1	S 7°33'05", W 45°14'15"	Feb. 21, 94	1.37 - 1.80 (1.03 - 1.26)
19	Ribeiro Gonçalves 2	S 7°33'16", W 45°14'36"	Feb. 21, 94	0.97 - 1.53 (1.13 - 1.29)
20	Tasso Fragoso (Santa Filomena 1)	S 8°28'16", W 45°44'33"	Feb. 20, 94	1.21 - 1.23 (1.18)
21	Santa Filomena 2	S 9°06'46", W 45°55'30"	Feb. 19, 94	0.96 - 0.97 (0.93)

Source: JICA Study Team

Note that the numbers in parenthesis show the survey results of the Phase II study, during dry seasons.

3.4 Characteristics of the Parnaíba River for the Navigation

The Parnaíba river shows the different features and characteristics in geographic aspects in each area throughout the river from Santa Filomena to Luiz Correia. The characteristics of the river are as follows.

(1) Amarante - Luiz Correia

The restrictive obstacle for the river navigation in this area is the water depth especially during in the dry seasons caused by the sand bars especially in the areas of Luzilândia and Fazenda Veneza.

The maximum water depth in the sand bar areas during dry season is estimated at 1.2 m for Luzilândia and 1.5 m for Fazenda Veneza.

There is one S-shaped sharp curve in the upstream area of the Igaracu river near the confluence of the Parnaíba river. The river has a corrade near Luzilândia where the observed flow velocity is at about 4 knots (2 m/sec).

Throughout this area, the flow velocity is reported at about 2 knots (1.0 m/sec) on average as shown in Table 3.3.2 although 3 knots (1.5 m/sec) is observed at Uniao.

(2) Amarante - Guadalupe

The river shows stable width and depth in this zone. However, there are two sharp curves between Floriano and Amarante and also a very narrow channel for navigation because of the corrade where rocks project on both sides of the river.

The flow velocity of the river is reported at 2.2 knots (1.1 m/sec) on average.

The restrictive obstacle for the river navigation in this area is the width of the river along the rocky outcrops.

(3) Guadalupe - Santa Filomena

Boa Esperança Locks restricts navigable ship's dimension physically and affects the passing time also.

The width is not sufficient and also there are some narrow channels with projecting rocks on both sides as in area (2) in this zone. The flow velocity is reported at 2.5 knots (1.3 m/sec) on average and partly exceeds 3.5 knots (1.8 m/sec) at Ribeiro Gonçalves.

Near Santa Filomena, the river has some very shallow points of approximately 1.5 m in the dry season.

At the upstream end between Santa Filomena and Ribeiro Gonçalves, the corrade makes the flow very fast and with some sharp curves of about 100m in radius, which means very careful ship operations will be required.

Balsas river, the branch of the Parnaíba river, has a very narrow width of about 40 - 70m and in the area between Urucui and Loreto, there are some shallow places of 1.5-2.0m in depth caused by sand bars. Upstream of Loreto, there are more shallow places which seem to be unsuitable for ship navigation.

Note that the aerial photography works were carried out during the dry season in 1993 to obtain the basic data for the preparation of mosaic photo, sand bar inventory and the selection of the construction site for the test spur dikes (see the Interim Report (I) and accompanied Supplemental Report for the details of the aerial photography works, mosaic photo, sand bar inventory and test spur dikes construction, respectively).

**4. TRAFFIC CONDITIONS AND
CARGO TRANSPORTATION IN
THE STATE OF PIAUÍ**

4. TRAFFIC CONDITIONS AND CARGO TRANSPORTATION IN THE STATE OF PIAUÍ

4.1 Transportation in the State of Piauí

The state of Piauí is one of the largest Northeastern states. Having the most natural resources available it can create conditions and opportunities to change this large potential into development.

The state of Piauí is strategically positioned relative to the Amazonian and Northeastern regions. Teresina, its capital, is placed on the right margin of the Parnaíba river, at the confluence with the Poti river, a convenient location because it comprehends one of the biggest highway and railway junctions with also airplane, metro and small ferry boat services.

In spite of its potential, the state of Piauí relies a lot for its provisions and living necessities on other states. These are mainly transported by means of truck and railway services nowadays. In the vicinity of Teresina and the Northern part of the State there is a convenient transportation network.

However finding a good transportation mode in the South-West region of State, especially in areas away from the principal roads, is difficult. Piauí has no ports facing to the Ocean, and therefore the gate ways for import and exports are at Fortaleza, Itaqui, Recife, Salvador and other principal ports.

Roads connect Teresina and other cities to all ports in order to transfer cargoes. Piauí is almost totally dependent on road transportation.

Railroads connect Teresina to Itaqui and Fortaleza.

There are four bridges across the Parnaíba river. One exists at Parnaíba city, two exist at Teresina city, with the remaining one at Floriano city. Truck transportation from Piauí to Maranhão or beyond Maranhão has to be made via these bridges and the return route to Piauí utilizes the same bridges. The road connects East and South regions of Piauí to the other states.

Piauí is rich in natural resources and also there are factories to process agricultural products. But the problem is that delays in the development of the Southwest have caused difficulties in increasing their cropping area and harvest because of the poor transportation methods. Before the construction of the dam, there was river transportation to carry these goods.

Accordingly, the Parnaíba river basin can be divided into three zones considering the present traffic conditions (see Figs 4.1.1 and 4.1.2 for the present conditions of the traffic network in the State of Piauí and the zoning of the river, respectively).

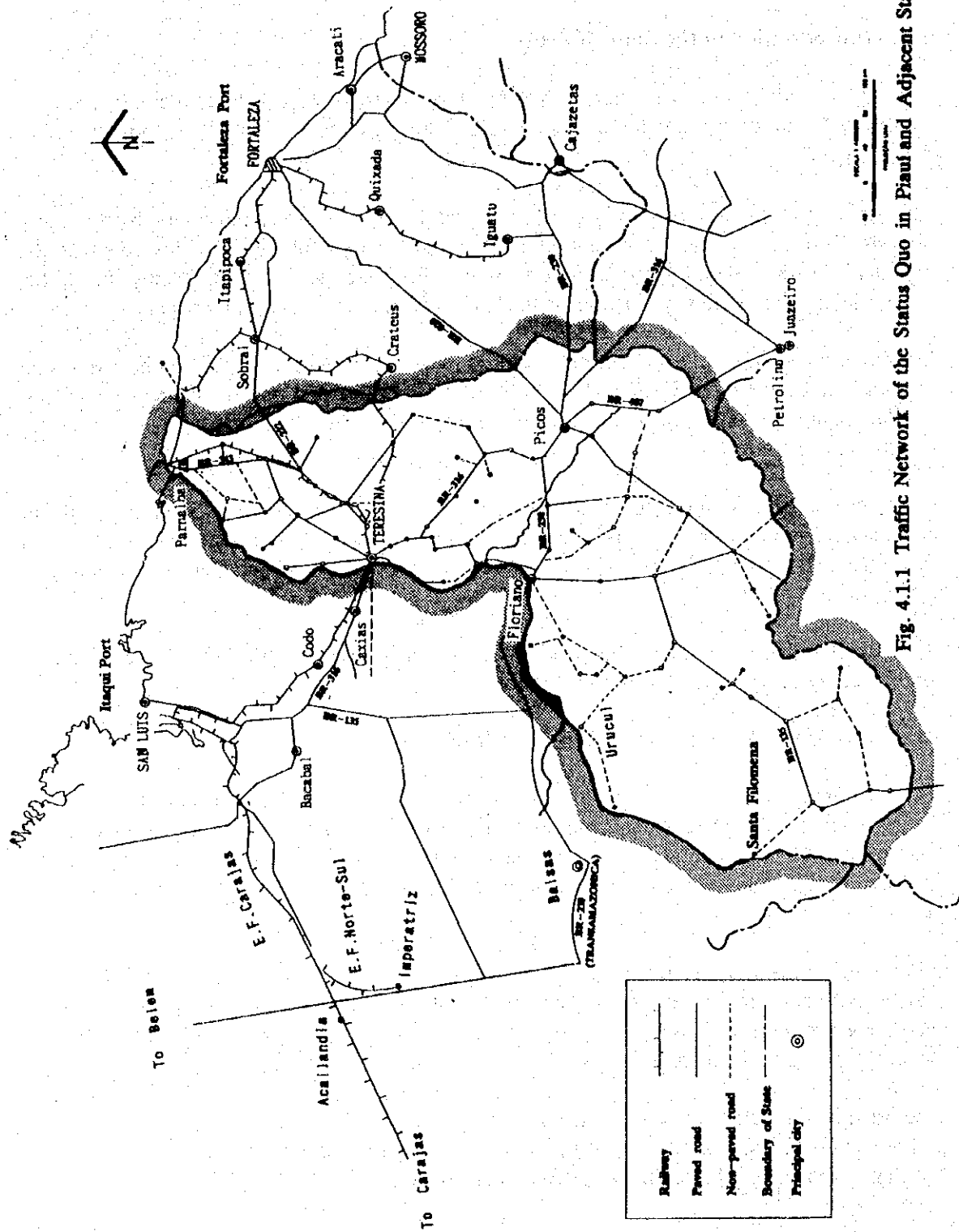


Fig. 4.1.1 Traffic Network of the Status Quo in Piauí and Adjacent State

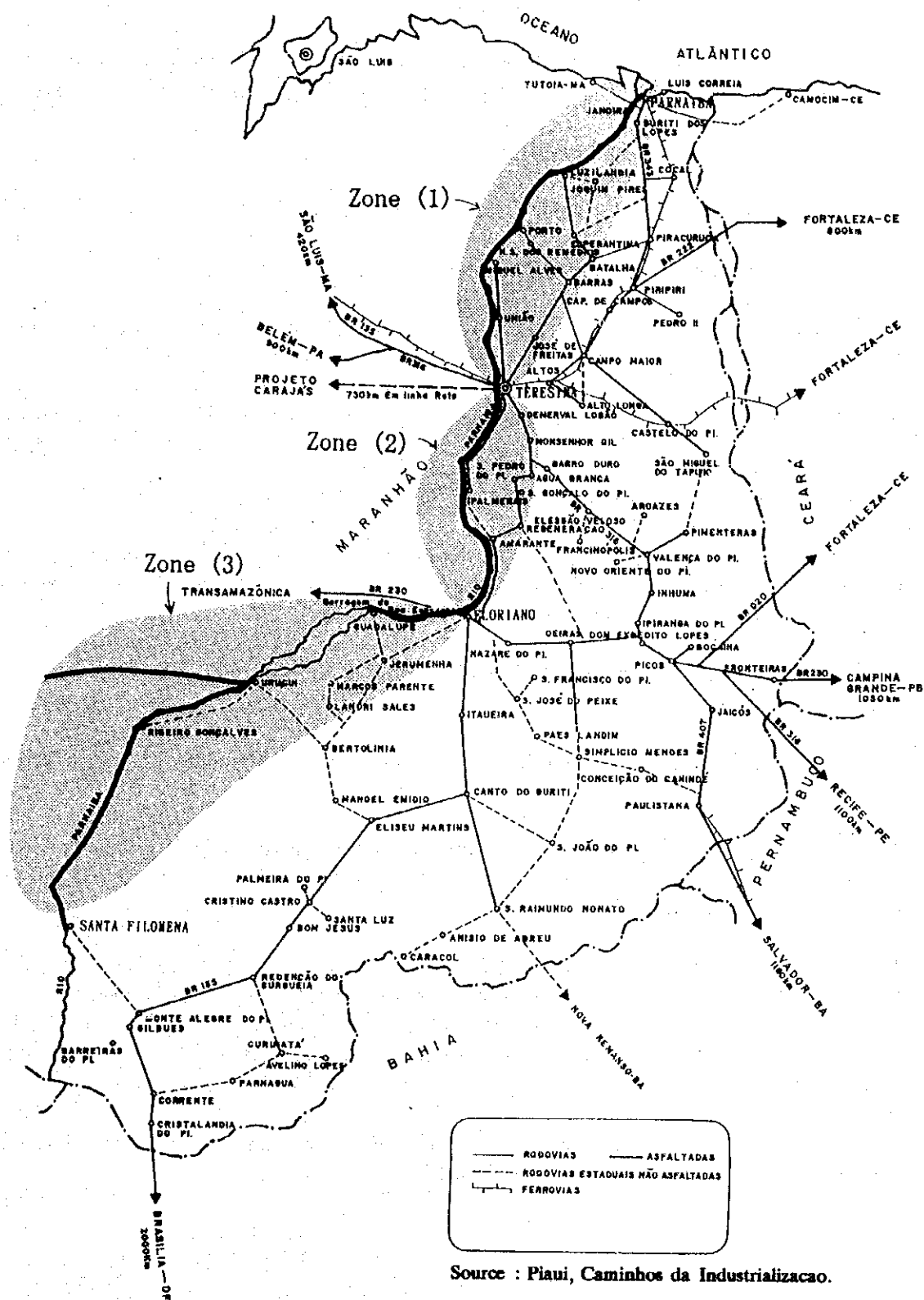


Fig. 4.1.2 Outline of Transportation in the State of Piauí

Zone-1 : from Luis Correia to Teresina.

This is one of the most developed areas and all kinds of transportation modes are concentrated - railway, road and water transportation will compete with each other.

Zone-2 : from Teresina to Floriano.

Road transportation will compete with water transportation.

Zone-3, from Floriano to Santa Filomena.

There is poor access to the upper region from Floriano. There is the possibility of competitor to make access to Carajas by railway via Balsas.

Individual explanations of the transportation modes in the State of Piauí are mentioned below.

4.2 Railway Transportation

The railway system is operated by Rede Ferroviaria Federal SA (RFFSA) which divides its 12 regions into SR-1 to SR-12 throughout the area of Brazil. The states of Piauí and Maranhão are affiliated with SR-12 and controlled under Sao Luis.

The railway, in Piauí according to RFFSA, has at present 523 km and the Teresina - Fortaleza stretch has 695 km.

5,000 passengers per day utilize the Metro Railroad service, extending 14 km, in Teresina city.

There are no plans to extend the railroad southward in the state of Piauí. A branch line, which reaches to Parnaíba city from Altos, ceased its operations in 1992 to avoid a deficit and there is no plan to resume this service.

Major commodities treated and passing Teresina are shown in the following Table 4.2.1. Freight will be decided by commodity, weight and distance. In addition, 3,000 tons of leather and 800 tons of Carnauba wax per year were transferred from Teresina to Fortaleza. Petroleum means Diesel Oil and Gasoline. Alcohol and Lubricating Oil are not included in Table 4.2.1.

The total weight of cargo transferred from/to Teresina by train is shown in Table 4.2.2. Weights of leather and Carnauba wax are included.

Table 4.2.1 Major Commodities Transported by Railway

Unit : Ton

Commodity	From	To	1989	1990	1991	1992	1993	Freight US\$/Km/T
Asphalt Cement	Fortaleza	Teresina	-	12,469	17,235	19,963	8,545	0.028
	Ceara, Maranhao	Teresina	45,385	48,420	49,547	30,576	35,623	0.016
Fuel Oil Petroleum	Fortaleza	Teresina	23,652	24,679	26,127	20,786	23,151	0.034
	Fortaleza	Teresina	178,889	189,842	189,950	201,800	179,541	0.037
Ceramics Iron Scrap	Teresina	Sao Luis	14,821	11,030	7,215	917	3,257	0.009
	Teresina	Fortaleza	358	199	618	850	2,392	0.012
Rice	Maranhao	Fortaleza	11,177	2,193	2,730	-	-	0.016
Pig Iron	Maranhao	Recife	61,711	43,886	54,558	66,629	75,806	0.011
Animal Feed	Maranhao	Fortaleza	4,244	2,958	3,878	1,650	1,650	0.014
Corn	Fortaleza	Sao Luis	4,548	84	10,368	6,174	1,015	0.014

Source : RFFSA

Table 4.2.2 Annual Weights From/To/Passing Teresina

Unit : Ton

	1989	1990	1991	1992	1993
From Teresina	18,978	15,029	11,633	5,567	9,449
To Teresina	247,926	275,410	282,859	273,125	246,860
Transit	81,680	49,121	71,534	74,453	78,471

Source : RFFSA

4.3 Air Transportation

The most important airport in the state of Piauí is at Teresina, used by B737 class aircrafts, and regularly served by VASP and VARIG. Aero-taxis attend the farthest points in the state.

Other airports are located in Parnaíba, Floriano and Picos; landing fields for small aircrafts are located in the main municipal seats.

In 1990, 5,620 landings and 5,633 take-offs were made at the Teresina airport. VARIG transported 485 tons of medicine for wholesale dealers and tropical fruits from Teresina to the other states and 675 tons of T.V.sets, radio, computer parts and car parts from other cities in Brazil to Teresina.

4.4 Road Transportation

(1) Present Situation

The roads constitute the main transport alternative in the State. They link all the regions in all directions and connect the farthest cities and settlements, beyond linking Piauí to neighboring States and to the rest of Brazil.

The most important highway axes in the State are: BR-343, which connects the littoral (Parnaíba) to the southeast, passing through Teresina and Floriano (after Teresina, it joins to BR-316); BR-222, which connects Piauí to Ceara (Fortaleza) from Piri-piri; BR-316, which connects Piauí with Maranhao to the west, and with Pernambuco to the east, from it deriving the BR-230, which goes to the State of Ceara and Parnaíba; BR-020, which connects Ceara and Brasilia through Piauí; BR-407, which goes to Pernambuco and Bahia; and BR-135, which goes to Bahia and Goias.

All federal roads are paved with asphalt, except for some stretches of the BR-020.

The total highway mesh of the State, according to DER figures, in 1992, was of 10,611.2 km, of these 2,417.5 km are federal, 5,185 km are State, 1,029.7 km are transitory state roads and 1,979 km are vicinal as shown in detail in Table 4.4.1.

Table 4.4.1 State Highway Mesh - 1992

Situation	Non Paved (km)			In Pavement Work (B)	Paved (Km) (C)	Total (Km) (A+B+C)
	Natural Bed	Implanted	Total (A)			
Federal	55.3	310.6	364.9	4.0	2,048.6	2,417.5
Transitory	-	639.0	639.0	-	390.7	1,029.7
State	336.0	3,785.0	4,121.0	-	1,064.0	5,185.0
Vicinal	-	1,979.0	1,979.0	-	-	1,979.0
Total	390.3	6,713.6	7,103.9	4.0	3,503.3	10,611.2

Source : DER/PI

The following Fig. 4.4.1 shows the Transition of Road Construction in the state of Piauí from 1970 to 1991 in order to understand the highway development of the State.

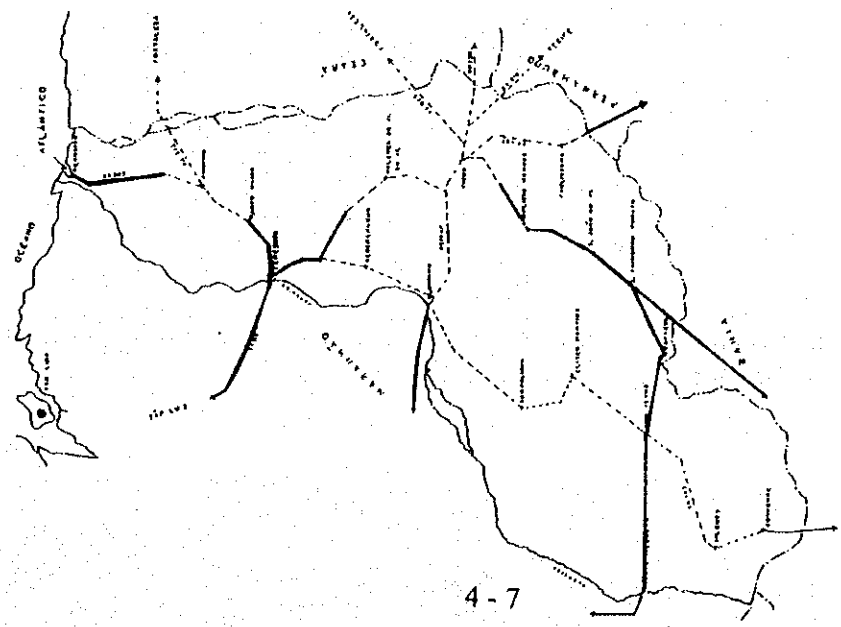
(2) Development Plan

The program is conceived as a Global Operation of Multiple Works, expanded in five sub-programs. The program's central objective consists to endow Piauí State with a highway system which allows larger and better integration of the State's several regions, and which can give conditions suitable for the implantation of agro-industries in these zones which today present a potential for this activity, especially in the Cerrado's zone and the Baixo Parnaíba region.

The program obeys the regionalization criterion established in the State Integrated Development Plan, PDI/PI - 1992/1995, and therefore it is compatible with the established priorities in the Transport Program. The program's execution term is for four years, according to the observed practice of the financial support. The following are the specific objectives of the program :

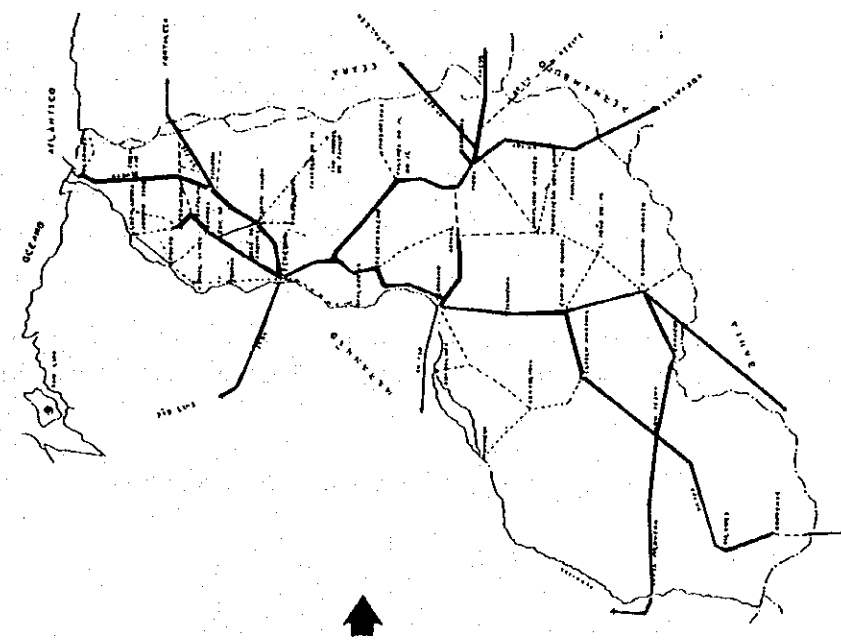
1. to restore 526 km of paved highway whose useful life has been depleted (in several regions of the States).
2. paving of 876 km, 442 km in the Southeast region and 434 km on the three highway axis in the North region of the State.

'70



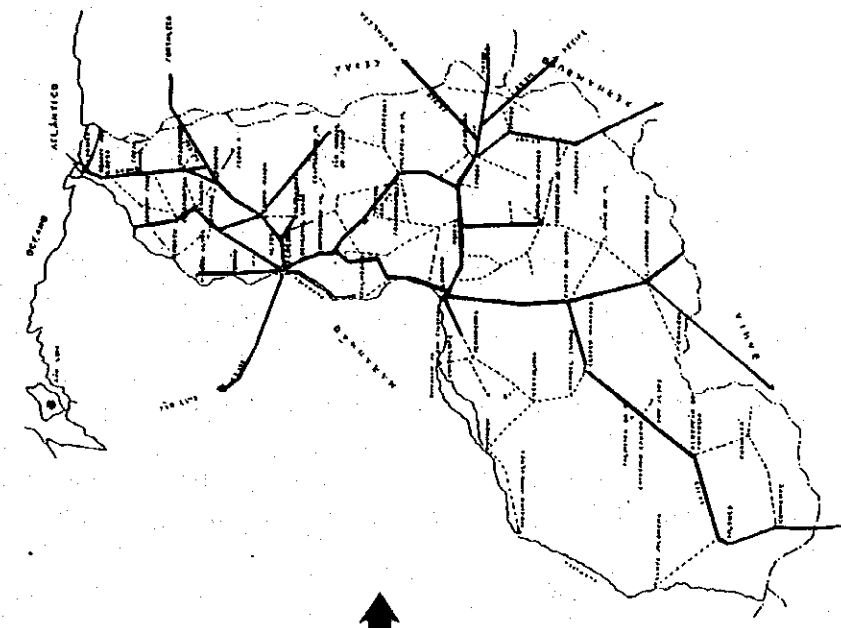
Paved Road Length about 240 km

'80



1,800 km

'91



2,300 km

— Paved Road

- - - Non-Paved Road

Fig. 4.4.1. Transition of Road Construction in the State of Piauí

3. rehabilitation of 134 km of vicinal roads and the building of 525 km of road, all being in the Southeast region of the state.

4. institutional development of the DER-PI, with special emphasis on personnel training.

Fig. 4.4.2 shows the Highway Development Program in the State of Piauí.

(3) Influence of the Highway Development on River Transportation

Some programs, Bertolina - Urucui, Urucui - Ribeiro Goncalves, Gilbues - Santa Filomena, Teresina - Parnaíba (via Vale do Parnaíba), will compete with river transportation, especially downstream of Teresina.

4.5 River Transportation

Present river transportation on the Parnaíba river basin is limited to the carriage of passengers and general cargoes by small ships within a short distance (several tens of km) and river transversing.

The longest trip is carried out by two ships of 20m length between Parnaíba and Luzilandia which operate two or three voyages per week. This long distance service compensates for the lack or the inconvenience of road transportation.

River transversing services and slipways for loading and unloading can be observed in major cities along the Parnaíba river basin. Table 4.5.1 shows the location of slipways along the Parnaíba river basin.

Table 4.5.1 Location of Slipways and Available Places for Small Ferry Boats

Location	Slipways	Ferry Boats
Parnaíba	x	x
Luzilandia	x	x
Miguel Alves	-	x
Uniao	x	x
Teresina	x	x
Palmeiras	x	-
Amarante	x	x
Floriano	x	x
Urucui	x	x
Ribeiro Goncalves	x	x
Santa Filomena	x	x

Source : JICA Study Team

Note that newly constructed concrete slipways were observed on the opposite bank to Amarante. The particulars of the slipways are as follows:

Length : 100 m
Width : 15 m

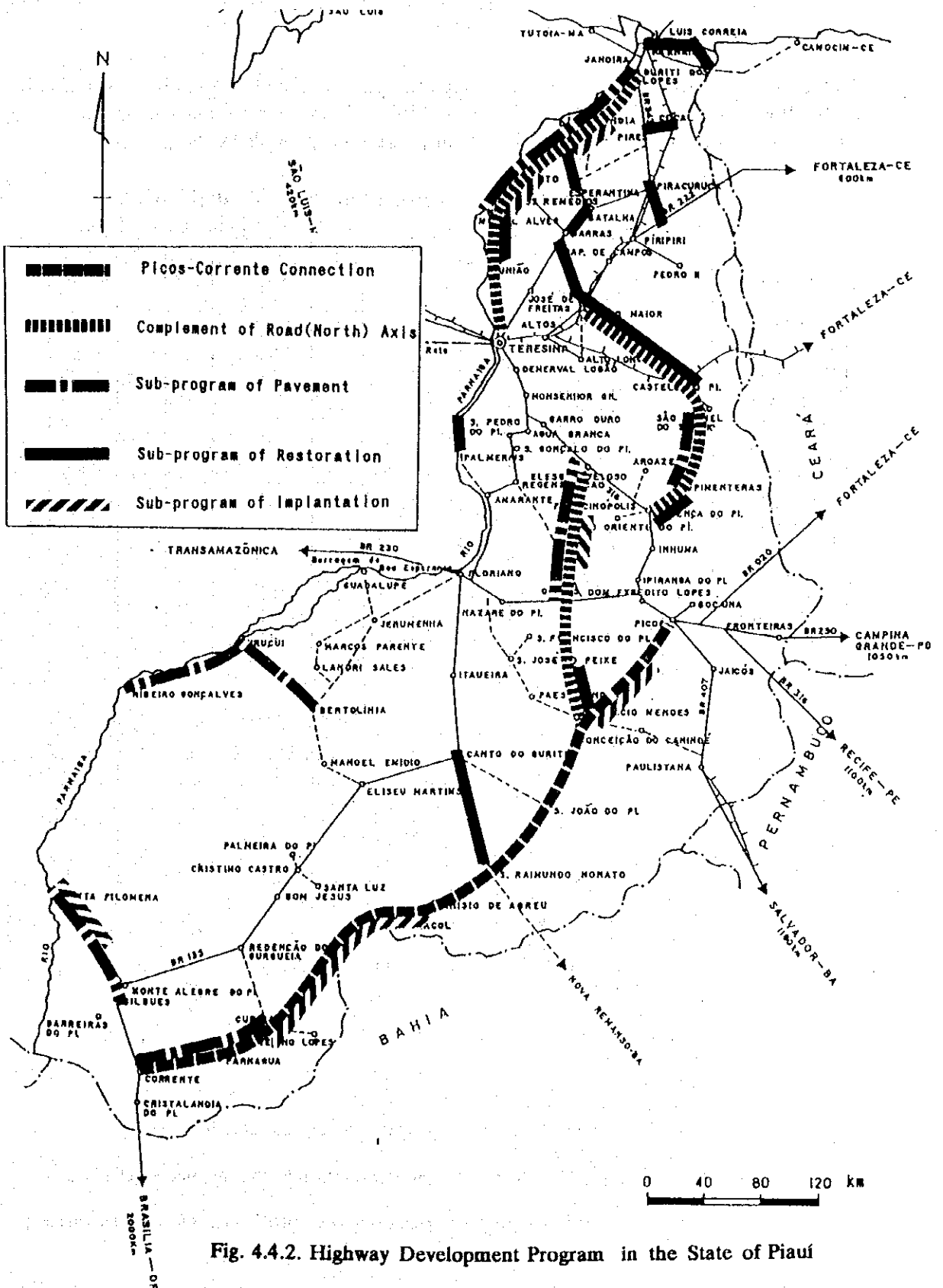


Fig. 4.4.2. Highway Development Program in the State of Piauí

Slope Inclination : 1:7 to 1:8
 Construction Period : 60 days (completed on Nov. 1993)
 Construction Cost : Cr\$ 9,900,000

The following tables show the number of ships navigating on the Parnaíba river basin classified by the Port Authority of the State of Piauí (CPPI) and indicates the number of ships in kind and area of service. Long Distance River Transportation is possible by these ships.

Table 4.5.2 Number of Ships Navigating on the Parnaíba River
 (The State of Piauí, Unit : ships)

	a	b	c	g	h	i	j	l	m	o	p	r	Total
Luiz Correia	-	-	1	-	-	3	-	-	16	-	-	-	172
Parnaíba	34	2	34	-	1	17	9	-	15	-	3	-	254
B. dos Lopes	1	-	8	-	-	5	1	-	25	-	-	-	40
Luzilândia	8	-	1	-	-	5	-	-	20	-	-	-	34
Porto	-	1	1	-	-	1	-	-	1	-	-	-	4
União	6	3	3	-	-	-	-	-	-	-	-	-	12
Teresina	29	15	15	3	3	2	55	4	14	8	2	2	152
Palmeirais	3	1	-	-	-	-	-	-	-	-	-	-	4
Amarante	8	5	1	-	-	2	1	-	-	-	-	-	17
Floriano	15	3	3	-	-	-	17	-	-	-	-	-	38
Guadalupe	-	-	-	-	-	-	-	-	7	-	-	-	7
Urucui	22	9	14	-	-	-	4	-	8	-	-	-	57
R. Gonçalves	1	-	-	-	-	-	-	-	-	-	-	-	1
Total	127	39	81	3	4	35	87	4	39	8	5	2	792

(The State of Maranhão, Unit : ships)

	a	b	c	g	h	i	j	l	m	o	p	r	Total
Timon	3	3	7	-	-	-	-	-	1	-	-	-	14
Parnamara	9	2	3	-	-	-	-	-	-	-	-	-	14
S. Francisco	3	6	-	-	-	-	-	-	-	-	-	-	9
B. Leite	6	3	2	-	-	1	1	-	-	-	-	-	13
Total	21	14	12	-	-	1	1	-	1	-	-	-	50

Source : Cap. dos Portos do Estado Piauí

Note : a : transport of passengers and cargoes

b : transport of passengers

c : transport of general cargo, dry cargo, and refrigerated cargo

g : tug boat / pusher

h : harbour

i : small commerce

j : sports / leisure

l : government

m : fishing boat

o : scientific investigation, exploration, prospector or study of commission

p : tourism and diverse

q : other service without commercial purpose (medical hospital assistance, religion and education)

r : other service with commercial purpose (ships for water storage, factory, industrial and similar)

The Parnaíba river was used for the water transportation of passengers, agricultural and livestock products until the 1960's between Santa Filomena and Parnaíba cities. However, the river transportation has declined since the construction of the Boa Esperanca Dam in 1965. This has two locks but these were suspended in 1982 because of financial problems.

Table 4.5.3 shows statistics by PORTOBRAS that indicates that the cargo movement of the Parnaíba river basin was 84,490 tons in 1950, but only 4,382 tons in 1965.

Table 4.5.3 Cargo Volume by River Transportation on the Parnaíba River Basin
Unit : tons

Year	Ton	Year	Ton	Year	Ton	Year	Ton	Year	Ton
1949	61,706	1953	32,600	1957	55,120	1961	22,193	1965	4,382
1950	84,490	1954	39,203	1958	22,850	1962	-		
1951	77,560	1955	35,740	1959	19,891	1963	5,023		
1952	55,460	1956	28,100	1960	-	1964	3,712		

Source : Empresa de porto do Brasil (PORTOBRAS), 1982

In the past, some ships carried cargo in the limited area after the Parnaíba river was dammed. A bulker of length 46m, breadth 10m, draft 1.4m transported 400 tons of salt from Parnaíba city to Floriano city in 11 days proceeding only in daytime. Another bulker of length 48m and breadth 10m transported 200 tons of salt from Urucui to near Ribeiro Goncalves.

4.6 Harbor Transportation

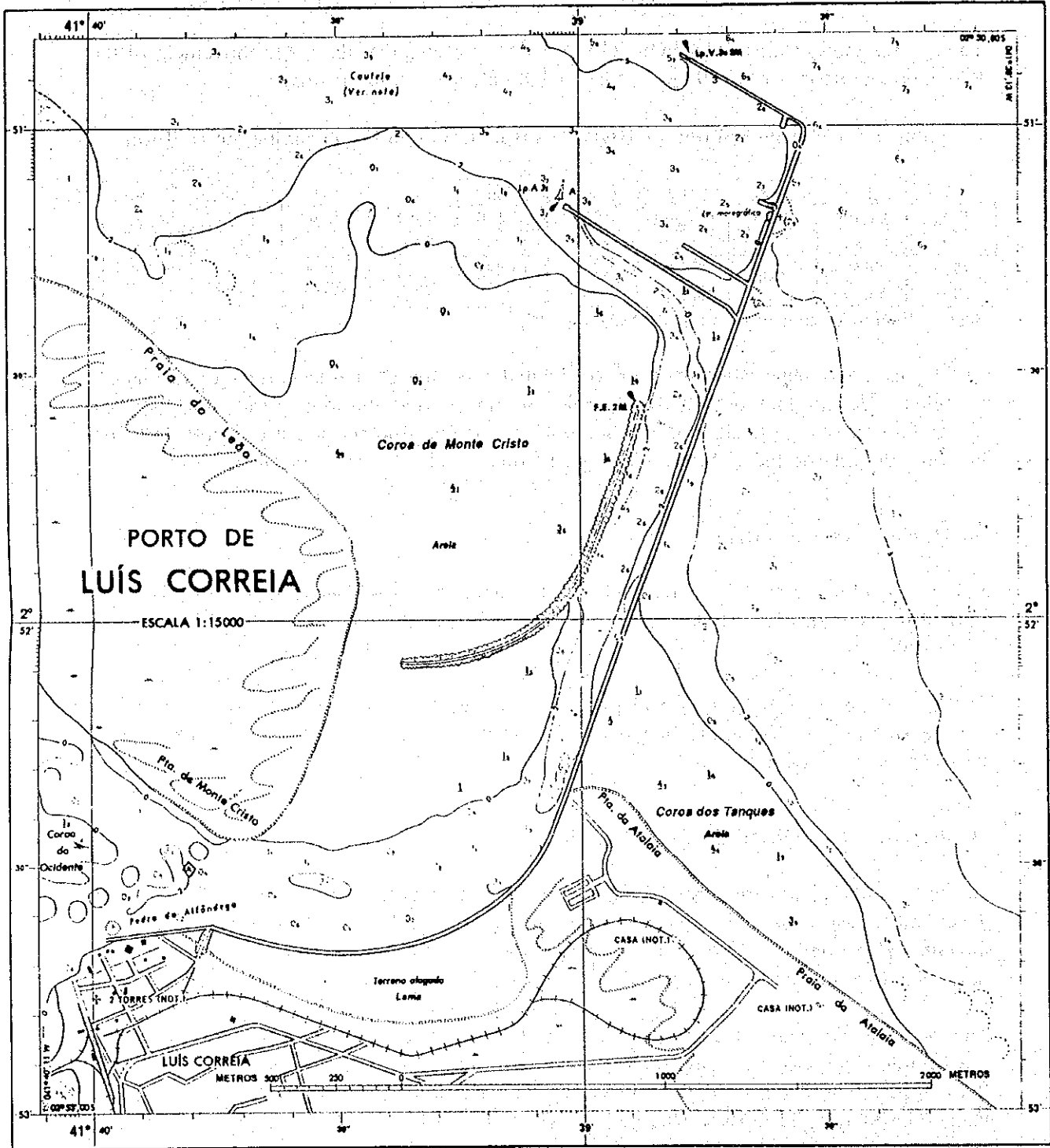
Luiz Correia Port located at the mouth of the Igaracu river was planned to be as the Gateway port of the state of Piauí. However, no transportation was observed except for fisheries on a small scale.

In the 1930's and 1940's, the Parnaíba city vicinity was a junction base of the Inland Water Transportation and Ocean Trade. After the damming up of the Parnaíba river, cargo movements on the river were reduced.

(1) Present Conditions of the Port Facilities

No major port facilities are located along the Parnaíba river although Luiz Correia Port as well as several slipways on the river bank at major cities along the Parnaíba river basin exist as port facilities. However, no activities for port operations at these facilities were observed. The following gives the present condition of Luiz Correia Port.

The development plan of Luiz Correia Port was established by PORTOBRAS and the breakwaters and training banks were constructed up until 1989. After the breakup of PORTOBRAS in March 1990, the rights to Luiz Correia Port were transferred to the State of Piauí. The State of Piauí then entrusted INACE (Industrial Naval do Cearra S.A.) with one berth construction for their own use. The construction, however, was suspended due to the financial problems of INACE. No further construction plan is available at this moment (see Fig. 4.6.1 for the present condition of Luiz Correia Port).



Source : Chart No. 515, December 1993

Fig. 4.6.1 Present Conditions at Luis Correia Port

According to the original development plan, the forecasted cargo volume to be handled in the port is 464 thousand tons in 1996, 21 thousand tons for deep sea transport cargoes, 440 thousand tons for coastal transport cargoes with 6 berths (250 meter length with 10 meters depth for one berth) for 10,000 DWT vessels planned.

Until 1986, 220,000 m³ of rock material was utilized for the construction of breakwaters and US\$ 58.8 million was invested. According to the data obtained by PORTOBRAS, a further US\$ 2.8 million was required for one berth construction civil works and US\$ 126 thousand for the mechanical works.

4.7 Other Related Transportation

(1) Fortaleza Port

Fortaleza port is located in the state of Ceara, about 650 km away from Luiz Correia port and has the following port facilities :

- Five berths with a length of 1054 m and a depth of 8 to 10 m
- Three warehouses (A1,A2,A3) with 53,000 tons of capacity in total for imported wheat and soybean.
- Three flour mills with 2,400 tons capacity in total per day
- Warehouse A4 is for imported cement and A5 is for export cargoes
- Pipe lines

There was 6,896 tons of export cargo passing through Fortaleza Port in 1993 which was produced in the State of Piauí. It is the second biggest volume next to the 14,447 tons of Rio Grande do Norte other than that produced in Ceara itself. Principal commodities were carnauba wax, animal skin, leather, clothes and so on. Almost all of these were transported by truck from Piauí to Fortaleza Port and then exported to USA, Europe and Asia.

Major commodities transferred from Fortaleza to Piauí were petroleum products, cement and flour. Petroleum products were transported by rail.

There are 22,000 TEU containers in this port. There is a plan to construct a new container berth with a length of 230 m and a depth of 14 m.

The following are the exported and imported cargo movements of Fortaleza Port.

Table 4.7.1 Cargo Handling Volume of Fortaleza Port

For Export Cargo				Unit : tons
	General Cargo	Bulk Solid	Bulk Liquid	Total
1988	137,783	38,950	82,882	259,615
1989	125,155	3,500	36,533	165,188
1990	148,237	-	66,517	214,754
1991	122,012	29,621	56,213	207,846
1992	145,058	35,376	63,871	244,305

For Import Cargo				Unit : tons
	General Cargo	Bulk Solid	Bulk Liquid	Total
1988	18,696	463,035	1,164,258	1,645,989
1989	18,929	376,525	1,202,367	1,597,821
1990	20,217	481,932	1,356,602	1,858,751
1991	52,954	518,399	1,333,032	1,904,385
1992	43,073	490,977	1,410,428	1,944,478

Source : COMPANHIA DOCAS DO CEARA

(2) Itaqui Port

Itaqui port is located in the bay of Sao Marcos, in the municipality of Sao Luis, capital of Maranhão. Ponta de Madeira and Alumar are very close together.

Itaqui port has three berths with a length of 716 m and a depth of 16 m to 19 m. There are three silos with a total capacity 28,000 tons, one warehouse with 6,000 tons capacity, and 28 tanks for Petroleum Products with 81,000 tons of capacity available.

Imported cargo commodities are shown as follows (port of export is added within parentheses)

- Petroleum Products (Bahia, Venezuela)
- General Cargo (USA, Europe)
- Wheat (Rio Grande, Argentina, Canada)
- Fertilizer (Russia, Israel)
- Coal (China)
- Cement (Caribbean district).

Exported cargo commodities are shown as follows (port of import is added within parentheses)

- Aluminium Ingot (USA, Europe)
- Pig Iron (USA, Europe)
- Manganese (Japan, Europe)
- Soybean.

Ponta de Madeira is an export terminal. Commodities are iron ore, manganese, soybean and pig iron.

Alumar imports bauxite, coal, pencil pitch and soda and exports alumina. A new berth is under construction of 500 m in length and 20 m in depth, acceptable for a 150,000 dwt type vessel. It will start service from the middle of 1994. The new berth will be connected to the Ponta de Madeira terminal with a belt conveyer and can load iron ore and soybean at the new berth. A new shiploader is also under construction with a loading rate of 8,000 tons per hour. The following is the export and import cargo movements of Itaqui Port.

Table 4.7.2 Cargo Handling Volume by the Terminal of Itaqui Port
For Export Cargo Unit : tons

	Itaqui	P/Madeira	Almar	Total
1989	314,917	31,793,811	398,346	32,507,074
1990	296,098	32,046,133	335,340	32,677,571
1991	443,817	32,838,200	258,602	33,540,619
1992	398,987	32,754,144	263,354	33,416,485
1993	430,197	34,977,876	323,462	35,731,535

For Import Cargo Unit : tons

	Itaqui	P/Madeira	Almar	Total
1989	1,088,721	-	2,280,169	3,368,890
1990	1,074,242	-	2,711,803	3,786,045
1991	1,023,223	-	2,900,906	3,924,129
1992	1,077,331	-	2,844,474	3,921,785
1993	1,139,687	-	2,817,593	3,957,280

Source : COMPANHIA DOCAS DO Maranhao

(3) Carajas Railway

In the North Exportation Corridor, which runs into Sao Luis, production was still reduced along the Carajas railway which links the mines of Para to Maranhao harbor.

Farmers came from the south discouraged with the low yield of the rice paddies in the region of Balsas, Maranhao. With the opportunity to use the railway to reach the harbor, the farmers began with soya. For 1993, 85,000 tons of soya were harvested in the region, triple that of the previous year. Almost all of the harvest was taken by truck to Imperatriz, on a 400 km road covered with asphalt.

The change to the trader's trains is made at Imperatriz, from where the load goes a further 92 km, the only stretch built of the North-South railway. In Acailandia, the wagons enter in the E.F.Carajas line, joining with the ore wagons on the route to Ponta de Madeira.

The "ride" with the ore is the most economical means of transportation and, includes the road until Imperatriz.

The income generated by the third party loads already covers 24% of the defrayal expenses of E.F.Carajas.

Beyond Balsas, the opportunity of following through the Carajas railway is opening new expansion fronts for soya production in Cerrados, in Piauí and in cities such as Urucui and Ribeiro Goncalves.

4.8 OD Table at the Status Quo

Cargo flow in the State of Piauí, between Piauí and other states is shown in the "OD table at the Status quo " by analyzing of existing publications, interviews to truckers at Posto Fiscal, competent authorities, the Chamber of Commerce and Industries and Enterprise. Also a questionnaire to 500 major companies in the State of Piauí was made.

The result is shown in Table 4.8.1 Present Flow of Transportation (OD Table) and the source of volume or weight of each cargo in the OD table is shown in Table 4.8.2.

4.8.1 Investigation of Truck Transportation

1950 samples of Truck Transportation, passing 7 locations of Posto Fiscal, were collected for the investigation of cargo data - Origin, Destination, Name of Commodity and Weight - from 10th February 1994 to 12th February 1994.

As a conclusion, almost all cargoes transit East-West in the State of Piauí, the main cargo flow concentrating on Teresina and then separating to other cities. Cargo transportation by truck in the State of Piauí showed the same tendency as "Traffic Flow on the Major Road in 1982 in the State of Piauí", which is shown in Fig. 4.8.1.

We have to understand the difficulties in analyzing the cargo flows which are transported by trucks in order to estimate demand for river transportation. Results of the investigation and interviews with the railway transportation personnel are shown in the OD table in Appendix 6. The area of the micro region of Posto Fiscal is shown in Fig. 4.8.2

4.8.2 Investigation of Questionnaire to 500 Companies

A questionnaire was sent to the major 500 companies that paid the most taxes as described in the "FAZENDARIA - ICMS 500 MAIORES DO ESTADO published by Secretaria de Fazenda in the State of Piauí.

64 answers were received which means 12.8% by ratio. The 64 samples correlate closely with the population in the ratio of type of industry and in the ratio of location of head office. But almost all answers had no information which referred to cargoes being carried along the Parnaíba river.

We had to understand which cargoes have the possibility to be transported by river transportation, even though there was a shortage of information. Notwithstanding this shortage, 38 companies showed their intention and anticipation of utilizing river transportation when river transportation on the Parnaíba was resumed.

As a result of the questionnaire, we could assumed some kinds of cargoes - Rice, Grain, Clothing, Carnauba Wax, Leather, Ceramics, Serums etc.- which could be transferred to other states or overseas (by river).

4.9 Seasonal Variation of Transportation

Conspicuous seasonal variations appeared in Agricultural products, depending on the harvest season, but these are expected to increase in production from year to year. Transportation of agricultural products increased about twice or three times during the harvest season, from February to May.

Other cargoes seem not have a seasonal variation.

Table 4.8.1 Present Flow of Transportation (OD table) Unit: Kilo Litre/Year (Petroleum Product) Unit:Tons/Year (Others)

	Upper Parnaiba Region	City of Floriano	Midium Parnaiba Region	Lower Parnaiba Region	Out of Parnaiba Basin	Other State
Upper						Rice Cashew nut
Floriano						
Medium	ceramics 2700 Petroleum Product 21300 LPG 2800 Wheat, Flour 6900 Sugar 6500 Fertilizer 61000 Cement 4000	ceramics 1000 Petroleum Product 7700 LPG 1050 Wheat, Flour 2500 Sugar 2400 cement 1400	ceramics 16200 Babassu Nut #2 6000 Petroleum Product 127000 LPG 17050 Wheat, Flour 28200 Sugar 26800 Fertilizer 6200 Cement 23700	ceramics 5900 Petroleum Product 47000 LPG 6200 Wheat, Flour 10200 Sugar 9800 Fertilizer 28300 Cement 8700	ceramics 24300 Petroleum Product 191000 LPG 25600 Wheat, Flour 42200 Sugar 40500 Fertilizer 19500 Cement 35700	Carnauba Wax 2600 Carnauba Powder 4100 Ceramics 200000 Clothing 800 Vegetable Oil 79000 Babassu Charcoal 3000 Babassu Oil 13000 General Cargo 19000
Lower	Salt 2700	Salt 300	Salt 8300 Babassu Nut #2 7000 Rice #3 10000	salt 4900	Salt 14100 Rice 10000	Carnauba Wax 700 Carnauba Powder 1000 Rice 20000
Out of Basin						Bee Honey 437 Textile 3000 Cashew Nut 17000 Marble 108500 Vermiculite 59000
Other State	Lime 413000 Salt 2400		Petroleum Product 394000 LPG 52700 Wheat, Flour 90000 Sugar 86000 Fertilizer 115000 Cement 73500 General Cargo #1 624000 Malt 24000 Babassu Nut #2 32000 Rice #3 10000		Cotton 5400 Salt 19500 Rice 29200	

Source : JICA Study Team

Range of Upper Parnaiba Region (From Santa Filomena to upper stream of Floriano)
District City of Floriano

Medium Parnaiba Region (From downstream of City of Floriano to Teresina including Teresina)

Lower Parnaiba Region (Downstream of Teresina)

Out of Parnaiba River Basin (Out of Basin in the state of Piauí)

Other state (States exclusive of the state of Piauí)

*1 General Cargo transfers to Teresina from other state.

but flow of distribution in the state of Piauí is unknown.

*2 45,000 tons of Babassu Nut are gathered in medium Parnaiba Region, to be transferred to the other state after manufacturing.

*3 Flow of Rice is very complicate with transferring from/to other state and region

Petroleum Product, LPG, Wheat, Flour, Sugar, Fertilizer and Cement are transferred to Teresina from other state, then distributed in the state of Piauí.

Table 4.8.2. Source of Volume or Weight of Each Cargo on OD Table x: Applied

Cargo	Basis of Calculation	Interview at Posto fiscal	Interview at Office or Factory	Questionnaire	Anuario do Brasil 1992	Data of FAO census	Agricultural census	Others
Salt	Bovine cattle 20kg/year Goat 5kg/year Human being 5kg/year	x	x		x			x
Petroleum Product	394,000 kl in Piaui		x		x			x
LPG	52,739 tons in Piaui				x			x
Wheat, Flour	48.8kg/year/person					x		
Sugar	46.4kg/year/person					x		
Fertilizer	9,116,761 tons in Brazil				x			x
Cement	73,473 tons in Piaui				x			x
Malt	2,000 tons in a month		x					
Carnauba Wax	3281 tons in Piaui	x	x	x	x			
Carnauba Powder	5152 tons in Piaui	x	x	x	x			
Babassu Nut	Consumed 45,000 tons in Piaui, Maranhao		x		x			
Babassu Oil	Produced 13,087 tons in Piaui				x			
Babassu Charcoal	3,000 tons	x		x				
Vegetable Oil	90,000 tons in Piaui					x		
	4.1 kg/year/person							
Ceramics	250,000 tons		x	x				
Bee Honey	437 tons		x		x			
General Cargo			x					
Rice	44.3 kg/year/person	x		x			x	
Clothing			x	x				
Textile			x	x				
Cotton			x	x				
Cashew Nut	25,507 tons in Piaui						x	
Lime	2 tons/Ha		x				x	
Marble								x
Vermiculite								x

Source: JICA Study Team

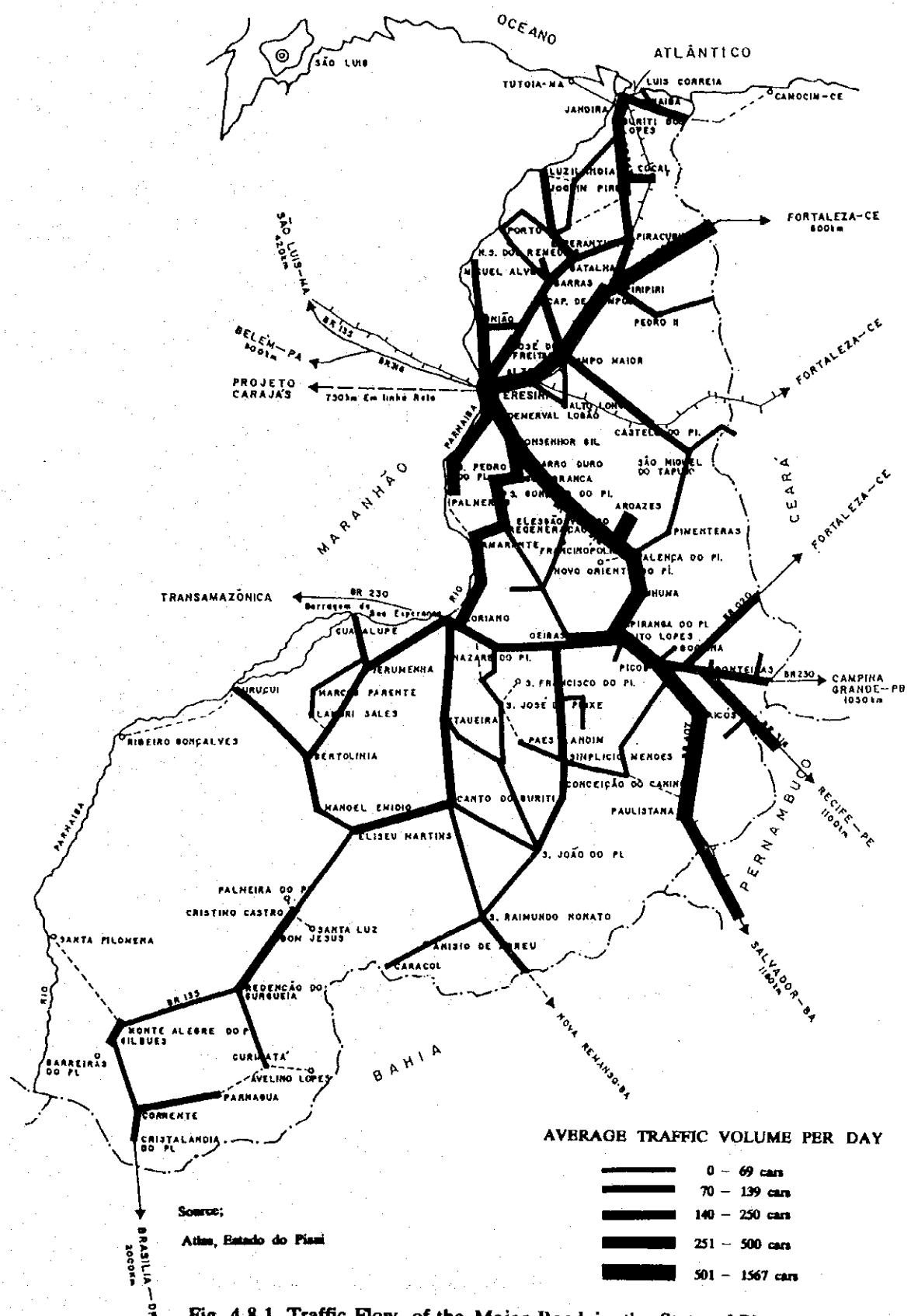


Fig. 4.8.1. Traffic Flow of the Major Road in the State of Piauí

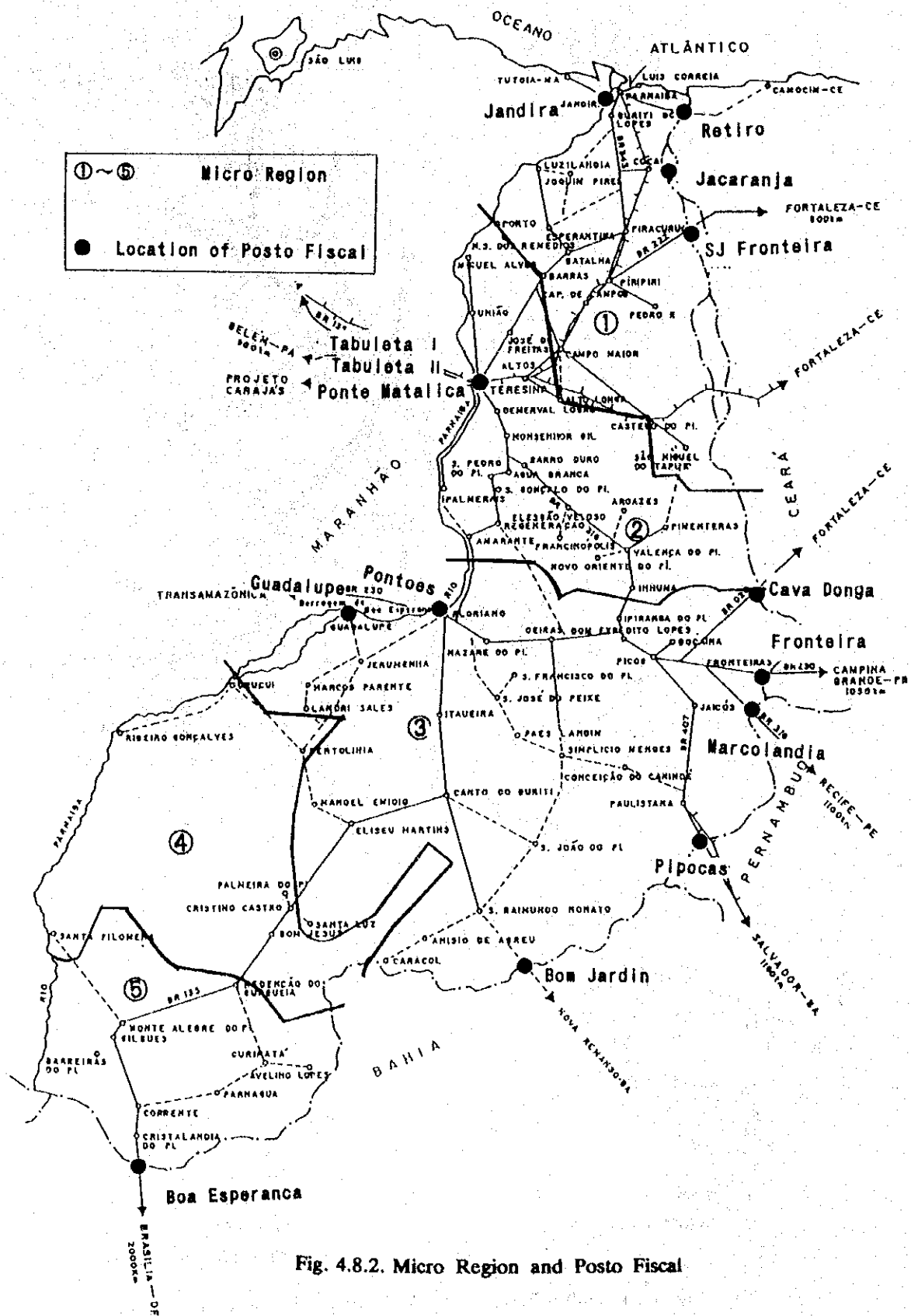


Fig. 4.8.2. Micro Region and Posto Fiscal

4.10 Transportation Costs

Transportation costs are based on all costs concerned with transportation (capital cost and running cost). For example, in the case of resuming river transportation on the Parnaíba river, transportation costs should be calculated from all costs considered characteristic of the Parnaíba river.

It is exaggeration to say that the first river transportation will start on the Parnaíba river because there are no facilities for river transportation except for slipways. Operating costs of river transportation depends on cargo weight, number of ships, size of ship, facilities for loading or unloading, berth or handling equipment on the berth etc.

For the reference, CESP in Sao Paulo shows river transportation costs on the Tiete river and the Parana river. Comparative transportation costs of waterways, railways and highways are US\$ 0.012 ton-km, US\$ 0.025 to 0.036 ton-km and US\$ 0.030 to 0.050 ton-km in the Tiete river, respectively.

Tariffs of Truck Transportation were filed in the Monthly Publication of INCT (Indice Nacional de Variacao de Coustos do Transporte Rodoviario de Cargas). The freight tariff depended on the commodity, distance and weight. But that tariff has ceased now. Table 4.10.1 shows the results of cargo freight by truck obtained by interviews with truckers at Posto Fiscal and a gas station from 21st January 1994 to 10th February 1994 in the State of Piauí. Table 4.10.2 shows the comparative transportation costs of waterways, railways, highways. Transferring costs in Table 4.10.2 were obtained from CESP.

Table 4.10.1 Cargo Freight by Truck

Cargo	Weight (ton)	From	To	Distance (km)	Freight (US\$)	Freight/KmT on (US\$)
Bovine	14.7	TO	PI	1,200	700	0.040
Fejon		PI	SC	4,000		0.013
Cement	27	MA	MA	280		0.023
Fertilizer	27	MA	MA	564	254	0.017
Lime	27	CE	PA	2,000	500	0.009
Wheat	27	CE	PI	634	200	0.012
Wood	27	PA	CE	1,571	900	0.021
Chicken	24	CE	MA	1,070	800	0.031
Rice	15	TO	PI	1,400	400	0.020
Rice	27	MG	CE	2,500	520	0.008
Petroleum	15	PI	PI	845	640	0.050
Salt	27.5	RN	GO	2,700	1,500	0.020
Fertilizer	27	AL	MA	1,900	1,080	0.021
Rice	15	MA	PI	654	600	0.061
Wood	28	MA	PE	1,900	1,200	0.023

Source : JICA Study Team

Remark :

PI: Piauí

TO: Tocantins

SC: Santa Catarina

MA: Maranhao

CE: Ceara

PA: Para

MT: Mato Grosso

RN: Rio Grandc do Norte

GO: Goias

PE: Pernambuco

AL: Alagoas

Table 4.10.2 Transportation Cost Comparative Table (Agricultural Products)

Unit : US\$/tonkm

Transferring Unit : US\$/ton

Location	Products	Waterway	Railway	Highway	Transferring
Piauí	Rice	-	0.016	0.008 - 0.061	-
	Flour	-	-	0.012	-
	Fejon	-	-	0.013	-
	Corn	-	0.014	-	-
Tiete	Average	0.012	0.031	0.040	2

4.11 Necessity and Condition of River Transportation

- (1) Geographically, the State of Piauí lays North-South along a long narrow corridor, while, the major highways run East-West and make no contribution to the southwest regions of the State. Resuming of river transportation is necessary for the improvement of the upper Parnaíba region.
- (2) Resuming of river transportation is useful for the development of the upper Parnaíba region because there is no good access to the upper Parnaíba region from Floriano.
- (3) Resuming of river transportation would supply cheap transportation by carrying agricultural products downstream from the upper region, while fertilizers, feeds and salt would be carried upstream.
- (4) Transportation methods in most of the enterprises are fixed, and so to attract cargo, river transportation is required to be cheap, safe and reliable.

**5. AGRICULTURAL CONDITIONS
IN THE STATE OF PIAUÍ**

5 AGRICULTURAL CONDITIONS IN THE STATE OF PIAUI

5.1 General

The agricultural sector plays an important role in the Piauí state economy, contributing with 19 % to the gross domestic product (GDP) and employing 60 % of the total labor force. However its relative contribution to the GDP has declined in the last decade dropping from 23.5 % in 1970 to 19.0 % in 1987, whereas the service and the industrial sectors contributed with 57.6 %, and 23.4 % respectively in the latter year. The State Government still places a high priority on the agricultural sector, on which the majority of the state's large rural population depends as the main source of employment, income and livelihood. Contribution and growth rate of each sector are shown on Table 5.1.1.

Table 5.1.1 Contribution by Economic Sector
(Unit: %)

Sector	1970	1975	1980	1987
Agriculture	23.5	27.4	22.3	19.0
Industry	25.8	19.0	18.8	23.4
Service-rending	50.7	53.6	58.9	57.6

Taking into account its agricultural potential, water resources, land potential for agricultural use and labor force, the State of Piauí has planned to promote the economy of rural areas through agricultural development.

The agricultural sector contributes with over 56% of the primary sector GDP, followed by the Cattle Breeding sector with about 31 % and the Forestry sector, with 13 %. The State's cultures are classified in permanent and temporary. Among the temporary cultures - the most significant in economic terms - there are six outstanding products: rice, beans, cotton, corn, cassava and sugar cane, and recently, soybeans. Among the features of the State's agriculture it can be mentioned that it depends largely on small scale agriculture, has very low productivity and is mainly carried out in the form of subsistence agriculture. Thus, it is possible to increase agricultural production through the improvement of agricultural techniques.

In this study the state production volumes are based on data provided by the State Government.

5.2 Government's Agricultural Sector Development Policy

5.2.1 Agricultural Sector General Policy

The State Government development strategy stresses rural and regional development. This strategy aims to:

- Promote the State's social and economic development, through economic growth, creation of employment, reduction of the illiteracy level, improvement of health, education and sewage services.
- Improve agricultural productivity, through the implementation of an irrigation program, the encouragement of agro-industry and the development of the Cerrados region.

- Promote modernization and moralization of public sector services, through an administrative reform.
- Rehabilitate and improve economical structure, especially the agricultural frontier and irrigation programs.
- Improve the rural and urban population's income through the creation of employment that will also enable access to health services, housing and other social programs.

In the agricultural sector the main objective is to achieve regional development, especially in the south and southwest parts of the State considering their meagre agriculture and their natural potential. Specific objectives in this sector are the following:

- To incorporate 400,000 ha defined by the State's land discrimination process to the productive process.
- To extend temporary cultivation agriculture and promote perennial cultures in the southwest of the State.
- To establish an agro-industrial complex in the Gurgueia-Floriano region, considering the existing agricultural potential associated with the irrigation project.
- To enlarge the Teresina region agro-industrial center.
- To promote the creation of an agro-industrial center in Baixo Parnaiba.
- To promote the creation of a calcareous processing factory.
- To create 320,000 constant agricultural jobs.
- To enlarge essential physical infrastructure for development (roads, energy, communications and silos)
- To extend and improve the quality of public services.

The State government puts emphasis on the use of the following areas, in order to obtain the above mentioned specific objectives;

- Areas with good soil condition for constant or seasonal cultivation, where the land topography and physical conditions allow intensive use of modern agricultural machinery and mean precipitation offers good conditions for agriculture development.
- Plateau areas with good agricultural aptitude for temporary or permanent agriculture.
- Areas located in valleys, especially those close to Gurgueia river and within reach of the Mulato and Caninde rivers, such as Mean Parnaiba, Parnaiba and Longa, and Baixo Parnaiba, where irrigation practice is common.

In addition, the State Government is taking the following policies;

- Support Program for small scale farmers
- Fund for investment of Nordeste-FINOR
- PPIN-PROTERRA (Finance program for Cerrados region, irrigation project, community support, Production Cooperatives, water resources development project, etc)
- Constitutional Fund for Finance of Nordeste - FINE (Increment of small/medium scale agroindustries)
- Strengthen the State's planning system

5.2.2 Agricultural Sector Development Program

The agricultural sector policy established by the State Government for the period 1991/1994 is

composed of seven main programs as follows;

- Agriculture and Livestock Production Program
- Irrigation Program
- Agrarian Organization Program
- Technical Assistance Program
- Small Scale Rural Producer Support Program
- Support Program for Agricultural Goods Commercialization
- Fishery Program

The objectives of each program are shown on Table 5.2.1;

Table 5.2.1 Agricultural Policy Piauí: Basic Goals

Program	Unit	1991-1992	1993	1994	TOTAL
1. Vegetal and Animal Production Program					
Seed acquisition and distribution	tons	1,540	1,000	1,200	3,740
Fruit plants acquisition and distribution	tons	505	400	450	1,355
Calcium mill installation	units	2	1	1	4
Farm fairs	fairs	4	3	3	10
Cattle race control		2,815	1,500	1,500	5,815
Brucellosis control	benefited properties	977	800	800	2,577
Rabies control	ha	288	200	200	688
Soybean cultivation encouragement	benefited families	5,000	4,000	4,500	13,500
Tropical fruits cultivation encouragement		65	50	60	175
2. Irrigation Program					
Irrigation projects being carried out	ha	2,375	2,950	2,950	8,275
Projects negotiated in 1982 to be carried out in 1993	projects	0	3	0	3
Rising irrigable area potential					
Dams in construction by DNOCS	ha	4,400	5,000	6,000	15,400
Well drilling	dam	4	0	0	4
Irrigation projects rehabilitation	wells	72	40	40	152
Community irrigation projects	projects	8	4	4	16
Dams to be constructed by the PAPP Project	ha	0	1,024	700	1,724
	dams	0	52	50	102
3. Agrarian Reform Program					
Land incorporation to public patrimony	ha	4,553	20,000	30,000	54,553
Title deed handing to small producers	titles	1,137	3,361	2,200	6,698
Land redistribution	ha	0	60,201	40,000	100,201
Discriminatory action: lands to be taxed	ha	0	300,000	200,000	500,000
4. Technical assistance Program					
Direct assistance to producers on irrigation, fruit cultivation, cattle raising, etc.	assisted producers communities and	109,568	55,000	57,000	221,568
Support to rural communities and associations	associations	20	40	50	110
5. Support Program for the Small Rural Producer: PAPP					
Rural community production project establishment					
PAPP Program	project	0	14	12	26
Fruit production areas establishment	ha	0	4,003	3,800	7,803
Agroindustrial units establishment	units	0	9	8	17
6. Support Program to Agricultural Marketing					
Construction of producer's markets	markets	1	5	7	13
Farm products marketing	tons	390,000	220,000	300,000	910,000
Market information services	benefited municipalities	30	20	30	80
7. Fishery Program					
Fishermen abilities and material support	fishermen	100	350	400	850
Assistance to fishermen cooperatives	cooperatives	3	3	3	9

5.2.3 Regionalization and Creation of the Agroindustrial Center of Piauí State

In order to establish an adequate agricultural policy, the State's government divided the State into 8 regions and 4 agro-industrial centers shown in Fig. 5.2.1. These regions are;

- 1: Teresina Industrial and Agro-industrial Zone
- 2: Longa and Baixo Parnaíba rivers
- 3: Serras de Cangalhas and Grande
- 4: Caninde and Gurgueia/Picos rivers
- 5: Serra Bom Jesus de Gurgueia and Araripe
- 6: Chapada das Mangabeiras
- 7: Tabueiros do Sudeste Piauinense
- 8: Agro-industrial Complex of Rio Gurgueia/Floriano

The agro-industrial centers are;

- 1: Baixo Parnaíba Agro-industrial Center
- 2: Rio Balsas, Parnaíba and Gurgueia Agro-industrial Center
- 3: Petrolina - Juazeiro Agro-industrial Center
- 4: Barreiras Agro-industrial Center

a. Baixo Parnaíba Agroindustrial Center

This center will be benefited by the existing irrigation project because of the installation of processing facilities such as a rice mill, Babacu processing plant, etc. The mechanism of this agro-industrial center is shown in Figs 5.2.2 and 5.2.3.

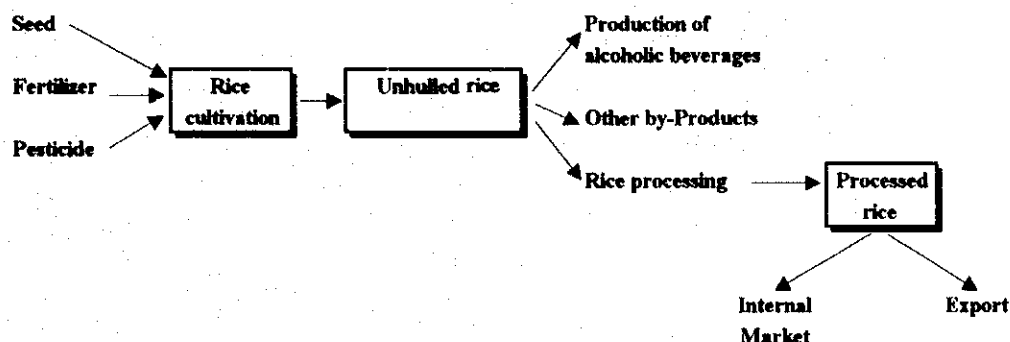


Fig 5.2.2 Rice Processing

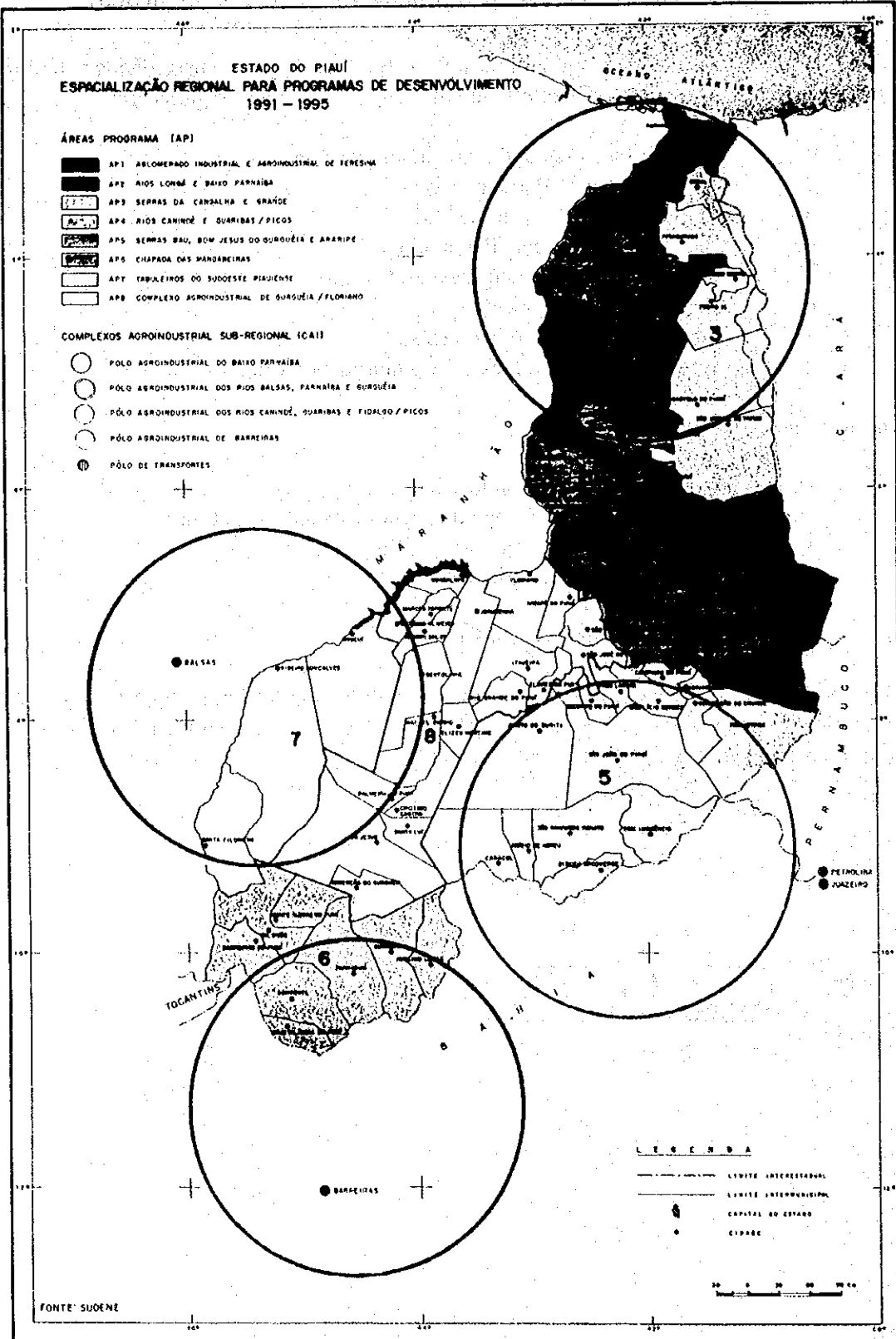


Fig. 5.2.1 Regional Division for Development Programs

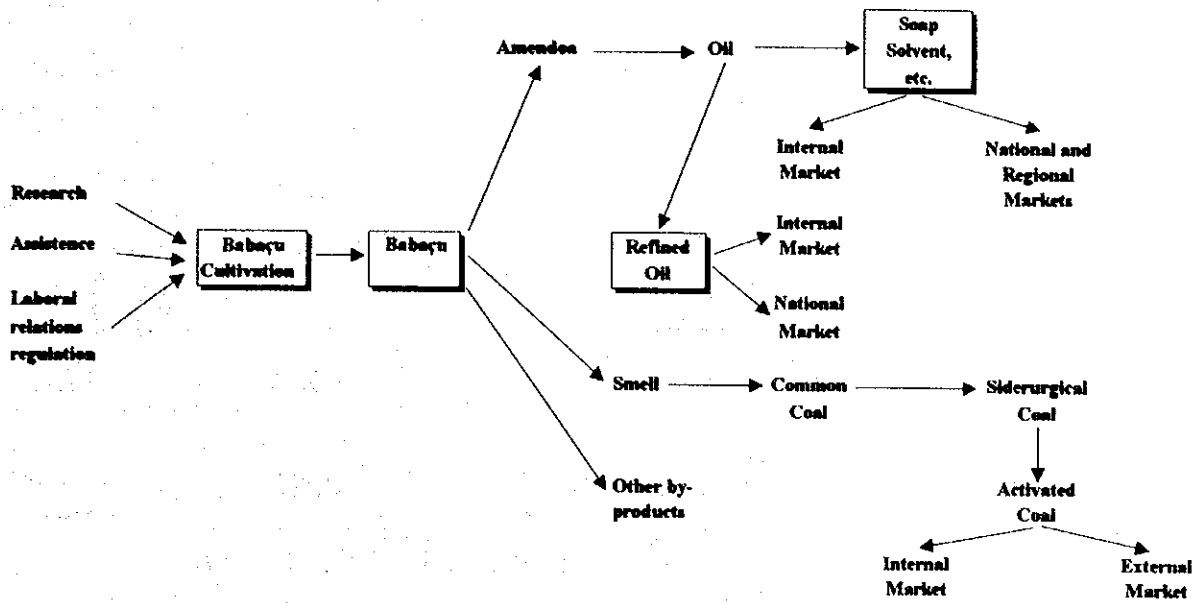


Fig. 5.2.3 Babaçu Processing

b. Balsas, Parnaíba and Gurgueia Rivers Agroindustrial Center

This area encloses three zones with a high natural resources potential, including the Gurgueia and the Itauera rivers and Boa Esperanza Dam areas. In this area, production of rice, soybean and corn has been increasing during the last decade. Cattle raising is also important. The mechanism of this agro-industrial center is shown in Fig. 5.2.4, and Fig. 5.2.5.

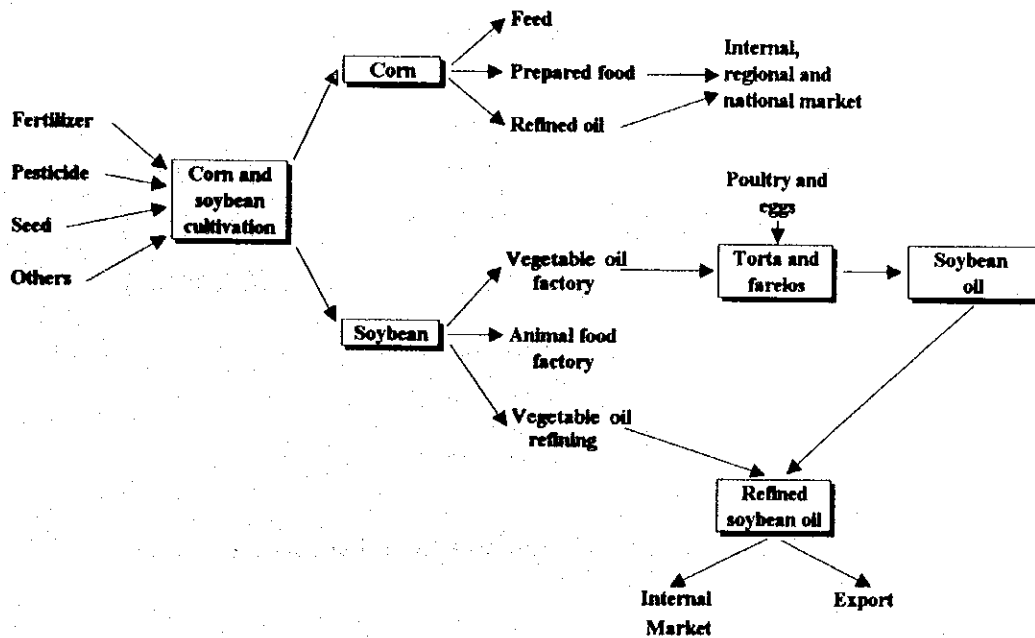


Fig. 5.2.4 Corn and Soybean Processing

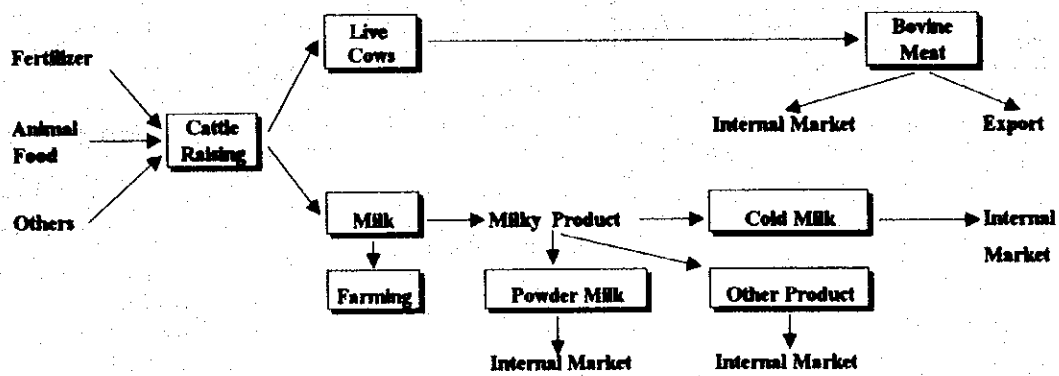


Fig. 5.2.5 Livestock Processing

c. Juazeiro-Petrolina Agroindustrial Center

In this agro-industrial center, beans, cotton, and corn are the main cultures. The mechanism of this center is shown on Fig 5.2.6.

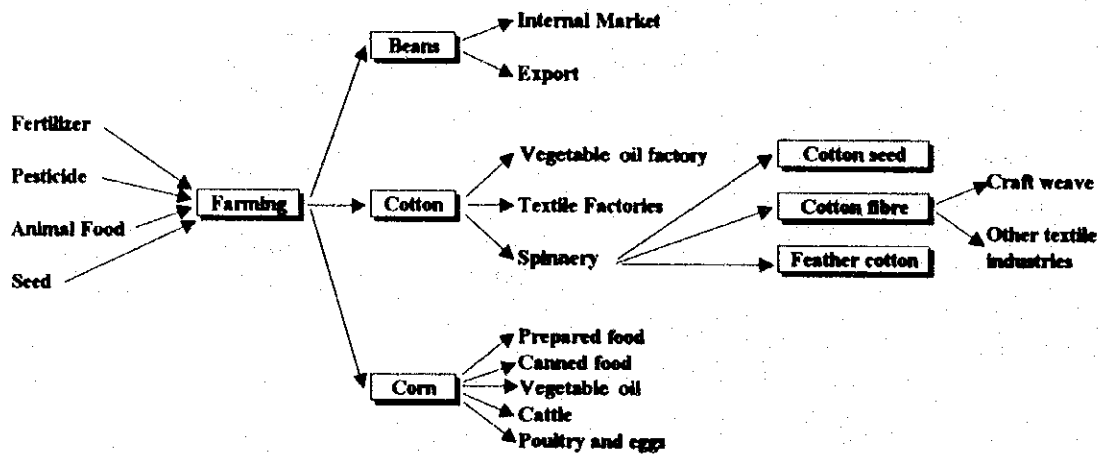


Fig. 5.2.6 Bean, Cotton and Corn Processing

5.3 Agricultural Sector Performance

5.3.1 General Framework

According to the Agricultural Census, the State includes 11,828,000 ha with 270,443 farms distributed as follows (Table 5.3.1);

Table. 5.3.1 Distribution of Agricultural Families and Cropping Area

Region	Establishment (No of Families)	Area (1,000 ha)
Total	270,443	11,828
Baixo Parnaíba Piauiense	35,749	4,900
Campo Maior	52,876	1,835
Medio Parnaíba Piauiense	18,232	369
Valença do Piauí	18,031	705
Baixos Agrícolas Piauiense	51,483	1,445
Teresina	28,750	703
Floriano	16,035	1,460
Alto Parnaíba Piauiense	3,391	1,037
Medio Gurgueia	4,374	600
Alto Piauí e Caninde	34,397	2,079
Chapadas do Extremo Sul Piauiense	7,125	1,049

(Source: Agricultural census - Piauí State/1985)

5.3.2 Production

Agriculture carried out in the State of Piauí consists mostly of subsistence agriculture; main crops are corn, beans and cotton. However, recently, the production of rice and soybean, which is carried out by enterprises, has increased, especially in the upstream region of the Parnaíba river. The soybean production in the State began in 1988, increased to 10,409 tons in 1994 and continues growing. Sugar cane is almost exclusively produced in middle Parnaíba (Teresina, União, José de Freitas Barras) with a total production of 1.1 million tons for a harvested area of 12,000 ha. The southwest part of the State presents itself as a rice producer, specially the Ribeiro Gonçalves city, with 34,263 tons and Urucui with 25,150 tons. The larger production is the result of the Tax policy applied by the State Government, through which large agricultural and cattle raising projects were implanted, emphasizing cattle raising and the industrialized plantation of cashew nuts and passion fruit. Rice cultivation has been carried out under seasonal planting, with results better than expected. In the middle and low Parnaíba, there are some private irrigation projects operating, where rice cultivation is carried out. A Federal Project is also being implemented for this crop. The farming area in the State of Piauí is indicated in Table 5.3.2.

Table 5.3.2 Cultivated Area

(Unit : 1,000 ha)

Culture	1985	1986	1987	1988	1989	1990	1991
Corn	363.4	444.2	363.8	455.7	428.3	394.7	418.2
Beans	277.9	316.3	261.0	337.2	276.1	270.0	282.6
Beans	16.5	15.5	12.1	15.2	13.5	14.6	11.5
Rice	198.6	240.1	209.6	249.0	238.2	221.1	258.2
Paddy	11.5	12.5	12.6	14.2	14.5	14.2	15.1
Cassava	66.9	120.7	157.7	137.1	142.3	166.4	159.7
Cotton	212.0	218.8	197.6	204.3	183.0	140.0	109.6

(Source: State Secretary of Agriculture, Piauí)

a. Rice

Rice is one of the most significant products of the State's agricultural production. Its farming is spread all over the State; however, its industrial development is still incipient, consisting only of small traditional processing units for hull removing. The distribution of rice production is shown in Table 5.3.3.

b. Feijão Beans

This product is the basic protein source for a large part of the rural and urban population of the State, ranking among the major agricultural products. In the 1980/1982 period, this product showed an increase not only in cultivated area, but also in yield.

The feijão bean production is basically concentrated in agricultural low lands in four homogeneous micro regions, Campo Maior, Upper Piauí, Caninde and Valença Piauí. (Table 5.3.4)

c. Corn

Corn farming ranks first in the State in terms of harvested area. Its industrial development could be achieved through the implementation of animal food manufacturing units. It is important to point out that both the State and the regional market bring animal food from other regions to feed their herds. (Table 5.3.5)

d. Cotton

Taking into account its industrial development, cotton farming is one of the most promising investment opportunities in the State. It occupies a significant harvested area of 212,000 ha with 31 % of the total production transformed into plume. The rest of the production is partially industrialized in the State; however, the larger part is processed in other States of the region.

e. Caster Oil Plant

This is one of the crops with the largest expanding perspective because of its use as a fuel source. Local production has been absorbed by the states of Ceará and Pernambuco because of the unavailability of transformation units in the State of Piauí.

f. Sugar Cane

Sugar cane is an agricultural product that has been arousing great interest among entrepreneurs, increasing its agricultural frontier. At present, the state has an industrial plant for the production of alcohol; however, this crop is mainly used to manufacture rum.

g. Cassava

Cassava is a predominant crop all over the state, since the lands are good for its cultivation. At present it is used for human consumption as flour and, on a large scale, as animal food.

h. Regional Fruits

The State has a highly diversified production of regional fruits that could be used for industrial purposes. Among them, cashew, orange, banana, lemon, mango and coconut, show a production volume higher than the country's average.

i. Animal Breeding

Animal breeding, the most traditional economic activity of the State, has been for many years the main support of Piauí's economy. In the last decades, however, there has been a reduction of the gross production volume of the primary sector and of the State's economy as well.

This activity is virtually developed and constitutes an extensive exploitation system. Its major activities are cattle (beef and milk) and poultry raising. Their contribution to the gross production value, shows an average participation in the years 1975 and 1980 of about 38.2 % and 37.9 %, respectively. Cattle raising has increased yearly, showing a growth rate of 27% in the period of 1975/79. However, from 1979, a weather problem, the absence of infrastructure, traditional exploitation methods and the financial crisis, that affected all sectors of the economy, have contributed to the reduction of the herds. The State's government support, through technical assistance to producers and fairs and exhibitions in the main municipalities, as well as farming and animal breeding projects approved by SUDENE, is creating a faster growth of animal breeding in the new frontiers of the State: the valleys of the river Gurgueia and Urcui Preto.

Table 5.3.3 Distribution of Rice Production at Parnaíba River Basin

PIAUÍ STATE
RICE PRODUCTION AND PARTICIPATION PERCENTAGE BY MUNICIPALITIES
INFLUENCED BY THE PARNAÍBA RIVER
YEAR: 1994

	MUNICÍPIOS	NON IRRIGATED RICE		IRRIGATED RICE		TOTAL	
		Production (t)	%	Production (t)	%	Production (t)	%
1	Barras	10,920	4.02	-	-	10,920	3.60
2	Bateia	4,152	1.53	-	-	4,152	1.37
3	Cabeceiras do Piauí	2,060	0.76	-	-	2,060	0.68
4	Esperantina	6,300	2.32	-	-	6,300	2.07
5	Joaquim Pires	2,240	0.82	1,200	3.78	3,440	1.13
6	Luziândia	8,951	3.29	4,200	13.25	13,151	4.33
7	Mattias Olímpio	2,250	0.83	240	0.78	2,490	0.82
8	Miguel Alves	2,395	0.88	-	-	2,395	0.79
9	Nossa Sra. dos Remédios	898	0.33	-	-	898	0.30
10	Porto	1,764	0.65	2,720	8.58	4,484	1.48
11	Buriti dos Lopes	7,117	2.62	19,600	61.82	26,717	8.80
12	Parnaíba	2,670	0.98	2,060	6.50	4,730	1.56
SUB-TOTAL		51,717	19	30,020	95	81,737	27
13	Altos	5,785	2.13	-	-	5,785	1.91
14	Benedictinos	1,868	0.69	-	-	1,868	0.62
15	Colvares	1,231	0.45	-	-	1,231	0.41
16	Demerval Lobão	1,876	0.69	-	-	1,876	0.62
17	Jose de Freitas	6,552	2.41	-	-	6,552	2.16
18	Miguel Leão	1,173	0.43	-	-	1,173	0.39
19	Monsenhor Gil	3,270	1.20	-	-	3,270	1.08
20	Lagoa Alegre	925	0.34	-	-	925	0.30
21	Teresina	6,793	2.50	1,348	4.25	8,141	2.68
22	União	4,040	1.49	-	-	4,040	1.33
23	Agricolândia	2,343	0.86	-	-	2,343	0.77
24	Água Branca	3,680	1.35	-	-	3,680	1.21
25	Amarante	3,807	1.40	-	-	3,807	1.25
26	Angical do Piauí	3,200	1.18	-	-	3,200	1.05
27	Arreal	532	0.20	-	-	532	0.18
28	Barro Duro	2,599	0.96	-	-	2,599	0.86
29	Francisco Ayres	1,675	0.62	-	-	1,675	0.55
30	Hugo Napoleão	2,872	1.06	-	-	2,872	0.95
31	Jardim do Mulato	1,659	0.61	-	-	1,659	0.55
32	Palmeiras	3,212	1.18	18	0.06	3,230	1.06
33	Passagem Franca do Pi.	2,566	0.94	-	-	2,566	0.85
34	Regeneração	3,962	1.48	-	-	3,962	1.30
35	São Gonçalo do Pi.	960	0.35	-	-	960	0.32
36	São Pedro do Piauí	6,580	2.42	-	-	6,580	2.17
SUB-TOTAL		73,160	27	1,366	4	74,526	25
37	Baixa Grande do Ribeiro	34,263	12.60	-	-	34,263	11.28
38	Ribeiro Gonçalves	8,715	3.20	-	-	8,715	2.87
39	Santa Filomena	7,266	2.67	-	-	7,266	2.39
40	Urucui	25,150	9.25	-	-	25,150	8.28
41	Antonio Almeida	8,315	3.06	-	-	8,315	2.74
42	Bertolínea	11,600	4.27	-	-	11,600	3.82
43	Colônia do Gurgela	1,150	0.42	-	-	1,150	0.38
44	Eliseu Martins	714	0.26	-	-	714	0.24
45	Landri Sales	2,000	0.74	-	-	2,000	0.66
46	Manoel Emdio	9,000	3.31	-	-	9,000	2.96
47	Marcos Parente	648	0.24	-	-	648	0.21
48	Canavieira	1,083	0.40	38	0.12	1,121	0.37
49	Flores do Piauí	1,860	0.68	-	-	1,860	0.61
50	Floriano	1,472	0.54	11	0.03	1,483	0.49
51	Guadalupe	849	0.31	270	0.85	1,119	0.37
52	Itaueira	3,660	1.35	-	-	3,660	1.21
53	Jurumenha	686	0.25	-	-	686	0.23
54	Nazara do Piauí	3,496	1.29	-	-	3,496	1.15
55	Rio Grande do Piauí	1,560	0.57	-	-	1,560	0.51
56	São Francisco do Piauí	847	0.31	-	-	847	0.28
57	São José de Peixe	1,025	0.38	-	-	1,025	0.34
58	Barreiras do Piauí	1,013	0.37	-	-	1,013	0.33
59	Bom Jesus	2,300	0.85	-	-	2,300	0.76
60	Cristino Castro	1,671	0.61	-	-	1,671	0.55
61	Gilbués	3,680	1.35	-	-	3,680	1.21
62	Monte Alegre do Piauí	6,720	2.47	-	-	6,720	2.21
63	Palmeira do Piauí	806	0.30	-	-	806	0.27
64	Redenção do Gurguela	1,480	0.54	-	-	1,480	0.49
65	Santa Luz	1,296	0.48	-	-	1,296	0.43
66	Corrente	2,052	0.75	-	-	2,052	0.68
67	Cristalândia do Piauí	684	0.25	-	-	684	0.23
SUB-TOTAL		147,061	54	319	1	147,380	49
TOTAL		271,938	100	31,705	100	303,643	100

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Table 5.3.4 Distribution of Feijão beans Production at Parnaíba River Basin

PIAUI STATE
BEANS PRODUCTION AND PARTICIPATION PERCENTAGE BY MUNICIPALITIES
INFLUENCED BY THE PARNAÍBA RIVER
YEAR: 1994

	MUNICIPIOS	FIRST CROP		SECOND CROP		TOTAL	
		Production (t)	%	Production (t)	%	Production (t)	%
1	Barras	330	3.39	150	3.67	480	3.47
2	Batalha	105	1.08	30	0.73	135	0.98
3	Cabeceiras do Piauí	47	0.48	20	0.49	67	0.48
4	Esperantina	110	1.13	-	-	110	0.80
5	Joaquim Pires	60	0.62	160	3.92	220	1.59
6	Luzilândia	231	2.37	840	20.58	1,071	7.75
7	Matias Olímpio	84	0.86	22	0.54	106	0.77
8	Miguel Alves	272	2.79	100	2.45	372	2.69
9	Noosa Sra. dos Remédios	16	0.16	5	0.12	21	0.15
10	Porto	32	0.33	22	0.54	54	0.39
11	Buriti dos Lopes	97	1.00	216	5.29	313	2.26
12	Parnaíba	144	1.48	-	-	144	1.04
SUB-TOTAL		1,528	16	1,565	38	3,093	22
13	Altos	354	3.63	-	-	354	2.56
14	Benedictinos	76	0.78	-	-	76	0.55
15	Coivaras	74	0.76	-	-	74	0.54
16	Demerval Lobão	14	0.14	-	-	14	0.10
17	Jose de Freitas	255	2.62	68	1.67	323	2.34
18	Miguel Leão	249	2.56	-	-	249	1.80
19	Monsenhor Gil	36	0.37	-	-	36	0.26
20	Lagoa Alegre	28	0.29	12	0.29	40	0.29
21	Teresina	247	2.54	-	-	247	1.79
22	União	280	2.87	120	2.94	400	2.89
23	Agricolândia	56	0.57	-	-	56	0.41
24	Água Branca	113	1.16	-	-	113	0.82
25	Amarante	36	0.37	150	3.67	186	1.35
26	Angical do Piauí	26	0.27	3	0.07	29	0.21
27	Aralá	65	0.67	25	0.61	90	0.65
28	Barro Duro	85	0.87	25	0.61	110	0.80
29	Francisco Ayres	42	0.43	88	2.16	130	0.94
30	Hugo Napoleão	66	0.68	-	-	66	0.48
31	Jardim do Mulato	50	0.51	-	-	50	0.36
32	Palmekais	28	0.29	-	-	28	0.20
33	Passagem Franca do Pi.	101	1.04	20	0.49	121	0.88
34	Regeneração	31	0.32	-	-	31	0.22
35	São Gonçalo do Pi.	28	0.29	-	-	28	0.20
36	São Pedro do Piauí	152	1.56	-	-	152	1.10
SUB-TOTAL		2,492	26	511	13	3,003	22
37	Baixa Grande do Ribeiro	436	4.48	-	-	436	3.15
38	Ribeiro Gonçalves	15	0.15	200	4.90	215	1.56
39	Santa Filomena	24	0.25	-	-	24	0.17
40	Urucui	96	0.99	-	-	96	0.69
41	Antonio Almeida	426	4.37	653	16.00	1,079	7.81
42	Bertolínea	252	2.59	-	-	252	1.82
43	Colônia do Gurgueia	113	1.16	150	3.67	263	1.90
44	Eliseu Martins	112	1.15	40	0.98	152	1.10
45	Landri Sales	201	2.06	-	-	201	1.45
46	Manoel Emídio	100	1.03	-	-	100	0.72
47	Marcos Parente	80	0.82	-	-	80	0.58
48	Canevieira	11	0.11	3	0.07	14	0.10
49	Flores do Piauí	265	2.72	-	-	265	1.92
50	Floriano	300	3.08	-	-	300	2.17
51	Guadalupe	92	0.94	-	-	92	0.67
52	Itaueira	610	6.26	-	-	610	4.41
53	Jurumenha	4	0.04	-	-	4	0.03
54	Nazare do Piauí	164	1.68	-	-	164	1.19
55	Rio Grande do Piauí	305	3.13	-	-	305	2.21
56	São Francisco do Piauí	91	0.93	-	-	91	0.66
57	São José de Peixe	124	1.27	-	-	124	0.90
58	Barreiras do Piauí	58	0.60	-	-	58	0.42
59	Bom Jesus	151	1.55	145	3.55	296	2.14
60	Cristino Castro	614	6.30	540	13.23	1,154	8.35
61	Gilbués	113	1.16	-	-	113	0.82
62	Monte Alegre do Piauí	103	1.06	-	-	103	0.75
63	Palmeira do Piauí	124	1.27	75	1.84	199	1.44
64	Redenção do Gurgueia	69	0.71	100	2.45	169	1.22
65	Santa Luz	92	0.94	100	2.45	192	1.39
66	Corrente	280	2.87	-	-	280	2.03
67	Cristalândia do Piauí	296	3.04	-	-	296	2.14
SUB-TOTAL		5,721	59	2,006	49	7,727	56
TOTAL		9,741	100	4,082	100	13,823	100

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Table 5.3.5 Distribution of Corn production at Parnaíba River Basin

PIAU STATE
CORN PRODUCTION AND PARTICIPATION PERCENTAGE BY MUNICIPALITIES
INFLUENCED BY THE PARNAÍBA RIVER
YEAR: 1994

	MUNICIPIOS	FIRST CROP		SECOND CROP		TOTAL	
		Production (t)	%	Production (t)	%	Production (t)	%
1	Barras	4,860	3.57	-	-	4,860	3.56
2	Batalha	3,600	2.64	-	-	3,600	2.64
3	Cabeceiras do Piauí	1,185	0.87	-	-	1,185	0.87
4	Esperantina	3,722	2.73	-	-	3,722	2.73
5	Josquim Pires	1,920	1.41	-	-	1,920	1.41
6	Luziândia	5,645	4.14	-	-	5,645	4.13
7	Martins Olímpio	1,716	1.26	-	-	1,716	1.26
8	Miguel Alves	1,848	1.36	-	-	1,848	1.35
9	Nossa Sra. dos Remédios	632	0.46	-	-	632	0.46
10	Porto	1,008	0.74	-	-	1,008	0.74
11	Buriti dos Lopes	2,668	1.96	-	-	2,668	1.95
12	Parnaíba	952	0.70	-	-	952	0.70
SUB-TOTAL		29,754	22	0	0	29,754	22
13	Altos	3,270	2.40	-	-	3,270	2.39
14	Benedictinos	1,785	1.31	-	-	1,785	1.31
15	Coivaras	302	0.22	-	-	302	0.22
16	Demerval Lobão	539	0.40	-	-	539	0.39
17	Jose de Freitas	3,870	2.84	-	-	3,870	2.83
18	Miguel Leão	780	0.57	-	-	780	0.57
19	Monsenhor Gil	2,103	1.54	-	-	2,103	1.54
20	Lagoa Alegre	441	0.32	-	-	441	0.32
21	Teresina	2,622	1.92	-	-	2,622	1.92
22	União	2,340	1.72	-	-	2,340	1.71
23	Agricolândia	993	0.73	-	-	993	0.73
24	Agua Branca	1,740	1.28	-	-	1,740	1.27
25	Amarante	563	0.41	-	-	563	0.41
26	Angical do Piauí	938	0.69	-	-	938	0.69
27	Arraial	746	0.55	-	-	746	0.55
28	Barro Duro	780	0.57	-	-	780	0.57
29	Francisco Ayres	982	0.72	-	-	982	0.72
30	Hugo Napoleão	594	0.44	-	-	594	0.43
31	Jardim do Mulato	488	0.36	-	-	488	0.36
32	Palmeiras	1,302	0.96	30	8.67	1,332	0.98
33	Passagem Franca do Pi.	788	0.58	-	-	788	0.58
34	Regeneração	688	0.51	-	-	688	0.50
35	São Gonçalo do Pi.	308	0.23	-	-	308	0.23
36	São Pedro do Piauí	1,575	1.16	-	-	1,575	1.15
SUB-TOTAL		30,537	22	30	9	30,567	22
37	Beira Grande do Ribeiro	1,812	1.33	-	-	1,812	1.33
38	Ribeiro Gonçalves	951	0.70	-	-	951	0.70
39	Santa Filomena	1,894	1.39	-	-	1,894	1.39
40	Urucui	2,102	1.54	-	-	2,102	1.54
41	Antonio Almeida	1,902	1.40	-	-	1,902	1.39
42	Bertolíneas	1,100	0.81	-	-	1,100	0.81
43	Colônia do Gurgueia	870	0.64	-	-	870	0.64
44	Eliseu Martins	762	0.56	-	-	762	0.56
45	Landri Sales	270	0.20	194	56.07	464	0.34
46	Manoel Emídio	1,792	1.32	-	-	1,792	1.31
47	Marcos Parente	504	0.37	-	-	504	0.37
48	Canavieira	1,568	1.15	1	0.29	1,567	1.15
49	Flores do Piauí	4,600	3.38	-	-	4,600	3.37
50	Floriano	2,050	1.50	21	6.07	2,071	1.52
51	Guadalupe	205	0.15	-	-	205	0.15
52	Itaueira	24,360	17.88	-	-	24,360	17.84
53	Jurumenha	216	0.16	-	-	216	0.16
54	Nazare do Piauí	1,144	0.84	-	-	1,144	0.84
55	Rio Grande do Piauí	13,300	9.76	-	-	13,300	9.74
56	São Francisco do Piauí	1,322	0.97	-	-	1,322	0.97
57	São José de Peixe	2,040	1.50	-	-	2,040	1.49
58	Barreiras do Piauí	207	0.15	-	-	207	0.15
59	Bom Jesus	1,330	0.98	100	28.90	1,430	1.05
60	Cristino Castro	1,480	1.09	-	-	1,480	1.08
61	Gibúes	288	0.21	-	-	288	0.21
62	Monte Alegre do Piauí	462	0.34	-	-	462	0.34
63	Palmeira do Piauí	975	0.72	-	-	975	0.71
64	Redenção do Gurgueia	875	0.64	-	-	875	0.64
65	Santa Luz	2,940	2.18	-	-	2,940	2.15
66	Corrente	1,860	1.37	-	-	1,860	1.36
67	Cristalândia do Piauí	758	0.56	-	-	758	0.56
SUB-TOTAL		75,937	56	316	91	76,253	56
TOTAL		136,228	100	346	100	136,574	100

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5.3.3 Irrigation Program

The irrigation Program of Piauí is carried out through the Companhia de Desenvolvimento do Piauí (COMDEPI) and the Departamento Nacional de Obras Contra as Secas (DNOCS). The list of irrigation projects is shown below;

Table 5.3.6 List of Irrigation Projects

Project	Location	Imple. Agency	Proj. Area (ha)	Irrig. Area (ha)
Loagoas do Piauí	Luzilândia	DNOCS	6,311	469
Vale do Fidalgo	Sim. Mendes	DNOCS	5,444	300
Gurgueia	Clistino Catro	DNOCS	12,886	1,974
Tabuleirão	Amarante	Alemão	500	40
Tableiros Litoraneo do Parnaiba	Buriti dos Lopes	SENIR	8,259	785
Platos de Guadalupe	Guadalupe	SENIR	32,000	-
Agua Limpa	Pimenteiras	Estad.	?	28
Campo do Forno	J. de Freitas	Estad.	14	14
Oho da Agua	Demerval Lobão	Estad.	380	31
Campestre	Teresina	Estad.	?	8
Ponta da Varzea	Amarante	Estad.	?	20
Lagoa das Araras	Amarante	Estad.	?	12
Cantinho	Barras	Estad.	?	20
Itaueira	Itaueira	Estad.	?	152
Santo Antonio	Campo Maior	Estad.	?	6
Piracuruca	Piracuruca	AVELAR	2,122	150
Campo Largo	Porto	AVELAR	600	100
Cajazeiras de Baixo	Buriti dos Lopes	AVELAR	424	-
Rio Grande	Rio. G. do Piauí	AVELAR	189	-
Varzea Grande	Buriti dos Lopes	AVELAR	277	-
Vale do Fidalgo	S.J.do Piauí	AVELAR	312	-
Vale do Sambito	Elesbão Loso	AVELAR	180	-
Cardeirão	Piripiri	DNOCS	1,200	388

(Source: JICA Study Team)

Note: From data submitted by SEPLAN-PI

5.3.4 Land Resources

The total surface of the state is 25,065,000 ha, 858,850 ha of which are irrigable and 9,825,000 ha form a potential area. The widest irrigable areas are located in Longa and Caninde, while the widest potential areas are located in Alto Parana and Gurgueia as shown in Table 5.3.7

Table 5.3.7 Irrigation Potential Land

(Unit:ha)

Region	Surface	Irrigable Area	Potential Area
1. Litoraneas	321,000	25,900	-
2. Baixo Parnaiba	799,000	159,000	400,000
3. Longa	2,120,000	299,400	201,000
4. Poti	3,913,000	92,900	976,000
5. Caninde	7,817,000	220,950	1,848,000
6. Itauera	1,204,000	11,200	882,000
7. Gurgueia	4,783,000	49,500	3,102,000
8. Alto Parnaiba	4,108,000	-	2,416,000
TOTAL	25,065,000	858,850	9,825,000

(Source: State's Irrigation Plan, COMDEPI, 1987)

5.4 Characteristics of the Agricultural Sector

5.4.1 General Framework

a. Condition of Piauí State Production

At present, the farming area of the Piauí State is about 11,828,000 ha exploited by about 270,000 families. Main crops are Feijão Beans, Rice, Cassava and Cotton. In Tables 5.4.1 and 5.4.2, average productivity of Brazil and Piauí State for each crop and the agricultural production volumes are shown.

Table 5.4.1 Average Productivity

Unit : t/ha

Crop	Brazil	State
Corn	1.97	0.19
Feijão Bean	0.47	0.12
Rice	2.04	0.45
Cassava	12.48	7.70
Cotton	1.27	0.19

(Source: Anuario Estadístico do Brasil - 92)

Table 5.4.2 Agricultural Production Volume in 1989

Unit : t

Crop	Brazil	State
Corn	26,572,592	363,527 (1.4%)
Feijão Bean	2,310,546	82,688 (3.6%)
Rice	11,044,453	407,914 (3.7%)
Cassava	23,668,473	2,012,495 (8.5%)
Cotton	1,813,399	5,706 (0.3%)

(Source: Anuario Estadístico do Brasil - 92)

b. Farming Area

Recently, the production of rice by farming enterprises has increased, especially in the upper stream region of the Parnaíba river. In Table 5.4.3, farming areas of the Microregion (81 and 92) by main crop are shown;

Table 5.4.3 Farming Area

Unit : ha

	Rice		Feijão Beans		Corn	
	81	92	81	92	81	92
Alto Parnaíba	9,740	68,100	1,526	1,619	2,380	8,870
Bertolina	-	15,220	-	4,720	-	7,810
Floriano	8,817	11,484	6,612	5,648	11,654	25,142
A.M. Gurgueia	3,879	8,720	3,868	4,030	-	5,585
S.R. Nonato	-	2,790	-	25,300	-	27,400
C.E. Piauiense	-	6,583	3,874	4,660	12,128	8,652
A.M. Caninde	4,530	5,443	36,765	56,198	45,918	79,755

(Source: JICA Study Team)

(Note: Data from Produção Agrícola Municipal - 81 and 92)

c. Characteristics of the Agriculture

The agriculture of the Piauí State is classified into two types; subsistence agriculture, predominating in the lower reaches of the Parnaíba river and entrepreneurial type in the upper area. Entrepreneurial agriculture was introduced recently because of the State's incentive policy, natural conditions and reasonable land prices. However, due to the lack of transportation facilities, the agricultural land expansion is stagnating.

d. Harvest period

In Table 5.4.4, the harvest period of rice, feijao beans and corn are shown;

Table. 5.4.4 Harvest Period

Crop	Harvest Period
Rice	
Upper Region	Approx. from April
Lower Region	" February
Feijão Beans	
First Crop	Approx. from September
Second Crop	Approx. from March
Corn	Approx. from March

(Source: JICA Study Team)

5.4.2 Production Cost

Production cost per hectare for the main crops are as follows;

Rice (Mechanized Rice Cultivation - Cerrado region) :	R\$ 381.12
Rice (Paddy) :	R\$ 772.33
Feijão beans (no irrigated) :	R\$ 296.00
Feijão beans (Irrigated) :	R\$ 667.80
Mixed Farming (Corn/Feijão) :	R\$ 171.50
Corn (no Irrigated - Cerrado region) :	R\$ 334.70
Corn (no irrigated - Baixa e Media Parnaiba region) :	R\$ 186.50
Soybeans (Mechanized area) :	R\$ 390.16

Detailed production costs are shown in Table 5.4.5 to Table 5.4.12.

Table 5.4.5 Detailed Production Costs - Rice (Mechanized Rice Cultivation - Cerrado region)

ITEMS	UNIT	QUANTITY	VALUE - R\$	
			UNIT	TOTAL
INPUTS				
Seeds	kg	60.00	0.53	31.80
Insecticide/Nematicide for seed treatment	kg	0.90	30.00	27.00
Insecticide for pest control	L	0.80	17.60	14.08
Urea	kg	88.80	0.37	32.86
Simple phosphates	kg	311.00	0.30	93.30
Potassium chloride	kg	75.80	0.37	28.04
SOIL PREPARATION				
Plough	h	3.00	24.00	72.00
Grader	h	1.00	24.00	24.00
SOWING				
Seed Treatment	h	0.20	2.20	0.44
Sowing	h	0.80	24.00	19.20
CULTURE TREATMENT				
Pesticide application	h	0.80	24.00	19.20
HARVEST				
Mechanized harvest	h	0.80	24.00	19.20
TOTAL (I)				381.12

OTHER COSTS: AFTER HARVEST

ITEMS	UNIT	QUANTITY	VALUE - R\$	
			UNIT	TOTAL
PROCESS AFTER HARVEST/ BEFORE COMMERCIALIZATION				
Transport and drying	R\$/t	2.20	3.18	7.00
Processing, classification and sacking	R\$/t	2.20	14.21	31.36
Packaging	R\$/t	2.20	8.63	18.99
TOTAL (II)				57.35
TOTAL (I) + (II)				438.47

FORESEEN PRODUCTIVITY: First year : 2,200 kg/ha.
From the second year: 2,500 k/ha.

Table 5.4.6 Detailed Production Costs - Rice (Paddy)

ITEMS	UNIT	QUANTITY	VALUE - R\$	
			UNIT	TOTAL
INPUTS				
Seeds	kg	100.00	1.00	100.00
Urea	kg	200.00	0.36	76.00
Triple Phosphate	kg	133.00	0.36	47.88
Potassium phosphate	kg	75.00	0.36	27.00
Insecticide	l	1.00	10.90	10.90
Fungi killer	kg	1.00	27.75	27.75
Weed killer	l	1.50	20.00	30.00
SOIL PREPARATION				
Area cleaning	h	1.00	25.00	25.00
Ploughing and levelling	h	4.00	25.00	100.00
SOWING AND FERTILIZER APPLICATION				
	h	1.50	25.00	37.50
CULTURE TREATMENT				
Pest control	h	2.00	2.90	5.80
Disease control	h	2.00	2.90	5.80
Hoes	h	2.00	2.90	5.80
Weed killer application	h	1.00	2.90	2.90
IRRIGATION MANAGEMENT				
	h	20.00	2.90	58.00
ELECTRICITY				
	kw/h	1,100.00	0.14	154.00
HARVEST				
	h	20.00	2.90	58.00
TOTAL				772.33

PRODUCTIVITY: 4,500 KG/HA.
PRODUCTION VALUE: R\$ 900.00

Table 5.4.7 Detailed Production Costs - Feijão Beans (non-irrigated)

ITEMS	UNIT	QUANTITY	VALUE - R\$	
			UNIT	TOTAL
INPUTS				
Seeds	kg	20.00	1.00	20.00
Insecticide	l	1.00	17.00	17.00
Fungi killer	kg	1.00	10.00	10.00
Ant killer	kg	1.00	10.00	10.00
SOIL PREPARATION				
Area cleaning	h	10.00	2.50	25.00
Ploughing and levelling	h	4.00	21.00	84.00
Sowing	h	3.00	2.50	7.50
CULTURE TREATMENT				
Manual culture	h	24.00	2.50	60.00
Weed pruning	h	2.00	2.50	5.00
Insecticide application	h	3.00	2.50	7.50
HARVEST AND PROCESSING				
Harvest	h	15.00	2.50	37.50
Processing	h	5.00	2.50	12.50
TOTAL				296.00

PRODUCTIVITY: 600 KG/HA.
 Price on community: R\$ 0.65/kg - R\$650.0/t

Table 5.4.8 Detailed Production Costs - Feijão Beans (irrigated)

ITEMS	UNIT	QUANTITY	VALUE - R\$	
			UNIT	TOTAL
INPUTS				
Seeds	kg	20.00	1.00	20.00
Urea	kg	40.00	0.37	14.80
Triple Phosphate	kg	170.00	0.30	51.00
Potassium phosphate	kg	50.00	0.37	18.50
Insecticide	l	1.00	17.50	17.50
Fungi killer	kg	1.00	10.00	10.00
Ant killer	kg	1.00	10.00	10.00
Energy	kwa	1,200.00	0.14	168.00
SOIL PREPARATION				
Area cleaning	h	1.00	21.00	21.00
Ploughing and levelling	h	4.00	21.00	84.00
Trenching	h	2.00	21.00	42.00
SOWING AND FERTILIZER APPLICATION				
Engine Traction	h	1.00	21.00	21.00
CULTURE TREATMENT				
Manual culture	h	22.00	2.50	55.00
Weed pruning	h	2.00	2.50	5.00
Water management	h	15.00	2.50	37.50
Ant killer application	h	1.00	2.50	2.50
Insecticide and fungi killer application	h	4.00	2.50	10.00
HARVEST				
Manual	h	22.00	2.50	55.00
PROCESSING				
Manual	h	10.00	2.50	25.00
TOTAL				667.80

PRODUCTIVITY: 1,400 KG/HA.
 Price: R\$ 0.65/kg - R\$ 650/t

Table 5.4.9 Detailed Production Costs - Mixed Cropping (Corn/Feijão)

ITEMS	UNIT	QUANTITY	VALUE - R\$	
			UNIT	TOTAL
INPUTS				
Seeds				
Corn	kg	15.00	0.30	4.50
Beans	kg	15.00	1.00	15.00
Insecticide	l	1.00	10.00	10.00
Ant killer	kg	1.00	10.00	10.00
SOIL PREPARATION				
Area cleaning	h	10.00	2.50	25.00
Sowing				
Beans	h	2.00	2.50	5.00
Corn	h	2.00	2.50	5.00
CULTURE TREATMENT				
Manual culture	h	12.00	2.50	27.00
Insecticide and ant killer application	h	2.00	2.50	5.00
HARVEST AND PROCESSING				
Harvest				
Beans	h	10.00	2.50	25.00
Corn	h	10.00	2.50	25.00
Processing				
Beans	h	3	2.5	7.5
Corn	h	3	2.5	7.5
TOTAL				171.50

PRODUCTIVITY: Corn: kg/ha=800 Price: 0.12/kg
 Beans: kg/ha=400 Price: 0.65/kg

Table 5.4.10 Detailed Production Costs - Corn (non irrigated - Cerrado region)

ITEMS	UNIT	QUANTITY	VALUE - R\$	
			UNIT	TOTAL
INPUTS				
Seeds	kg	20.00	0.30	6.00
Limestone	t	2.00	7.50	15.00
Urea	kg	100.00	0.37	37.00
Triple phosphate	kg	150.00	0.30	45.00
Potassium chlorate	kg	110.00	0.37	40.70
Insecticide	l	1.00	12.00	12.00
SOIL PREPARATION				
Ploughing	h	3.00	18.00	54.00
Levelling	h	1.00	18.00	18.00
SOWING				
Hole digging	h	2.00	2.50	5.00
Foundation cleaning	h	2.00	2.50	5.00
Sowing	h	1.00	2.50	2.50
CULTURE TREATMENT				
Hoes	h	18.00	2.50	45.00
Insecticide application	h	2.00	3.50	7.00
FERTILIZER APPLICATION				
	h	2.00	2.50	5.00
HARVEST AND PROCESSING				
	h	15.00	2.50	37.50
TOTAL				334.70

PRODUCTIVITY: 3,800 kg/ha
 PRICE: R\$ 0.12

Table 5.4.11 Detailed Production Costs - Corn (non irrigated - Baixa e Média Parnaíba region)

ITEMS	UNIT	QUANTITY	VALUE - R\$	
			UNIT	TOTAL
INPUTS				
Seeds	kg	20.00	0.30	6.00
Insecticide	l	1.00	12.00	12.00
SOIL PREPARATION				
Ploughing	h	2.50	21.00	52.50
Levelling	h	1.50	21.00	31.50
SOWING				
Hole digging	h	2.00	2.50	5.00
Sowing	h	1.00	2.50	2.50
CULTURE TREATMENT				
Hoes	h	18.00	2.50	45.00
Insecticide application	h	2.00	3.50	7.00
HARVEST AND PROCESSING				
	h	10.00	2.50	25.00
TOTAL				186.50

PRODUCTIVITY: 2000 kg/ha
PRICE: R\$ 0.12

Table 5.4.12 Detailed Production Costs - Soybeans (Mechanized area)

ITEMS	UNIT	QUANTITY	VALUE - R\$	
			UNIT	TOTAL
INPUTS				
Seeds	kg	75.00	0.60	45.00
Limestone	t	2.00	7.50	15.00
Fungl killer	kg	1.75	15.00	26.25
Inoculant	kg	1.50	1.20	1.80
Insecticide	l	0.80	17.60	14.08
Simple phosphate	kg	400.00	0.30	120.00
Potassium chlorate	kg	120.00	0.37	44.00
SOIL PREPARATION				
Ploughing	h	3.00	18.00	54.00
Levelling	h	1.00	18.00	18.00
SOWING				
Seed treatment and inoculation	h	0.40	2.20	0.88
Mechanized sowing	h	0.80	18.00	14.40
CULTURE TREATMENT				
Pesticide application	h	0.80	18.00	14.40
HARVEST				
Mechanized harvest	h	0.80	18.00	14.40
OTHER COSTS				
Transport and drying	R\$/t	2.5	3.18	7.95
TOTAL				390.16

PRODUCTIVITY: 2700 kg/ha

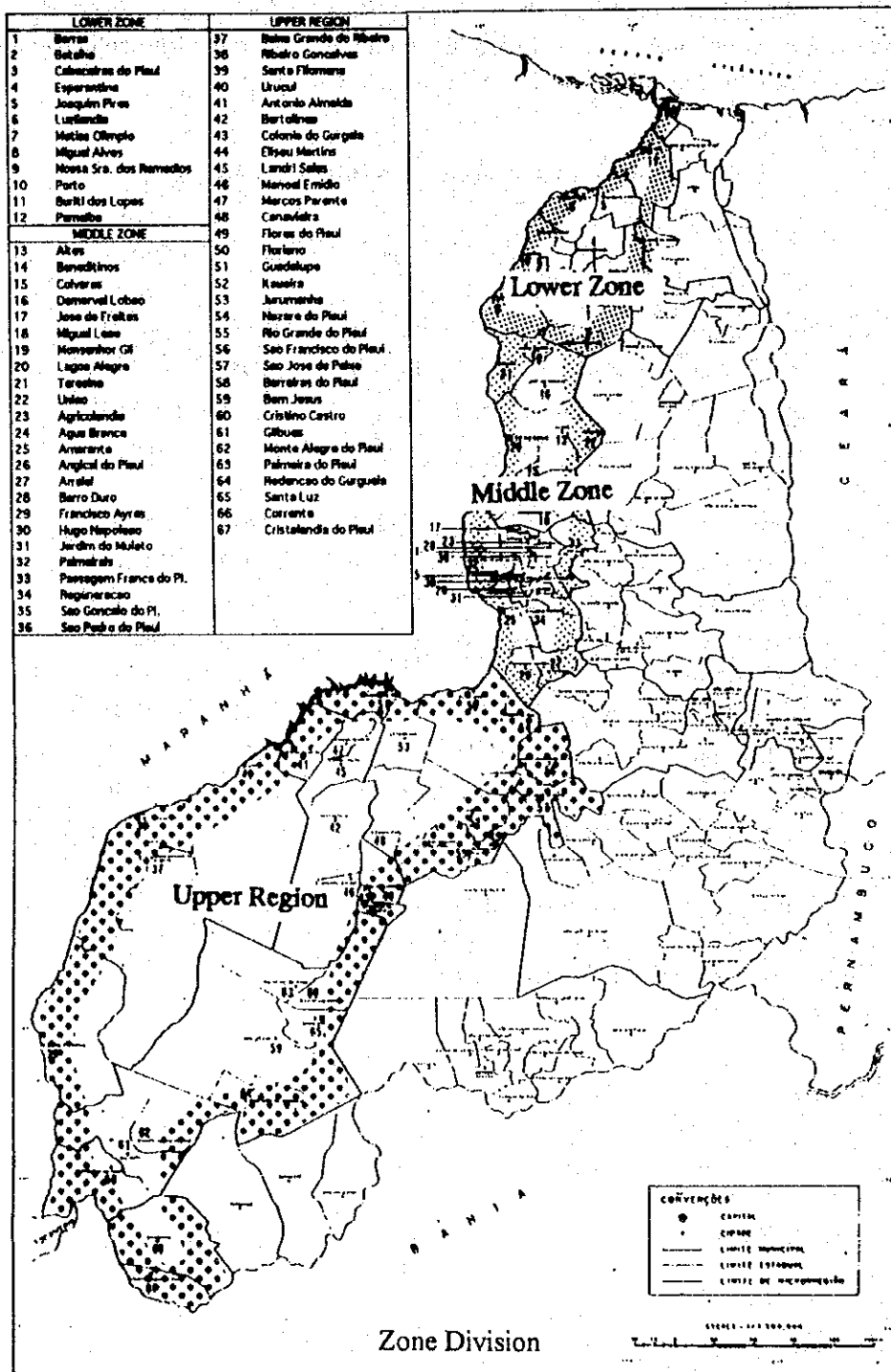
5.5 Estimation of Agricultural Production Volume

Estimated production volumes in the Parnaíba basin which were provided by the State Government are shown on Fig 5.5.1. Projected annual growth rates for each crop are; rice: 12.7 %, corn: 14.0 %, Feijão beans: 15.9 %, Soybeans: 26.9 %.

Table 5.5.1 Estimated Production Volume

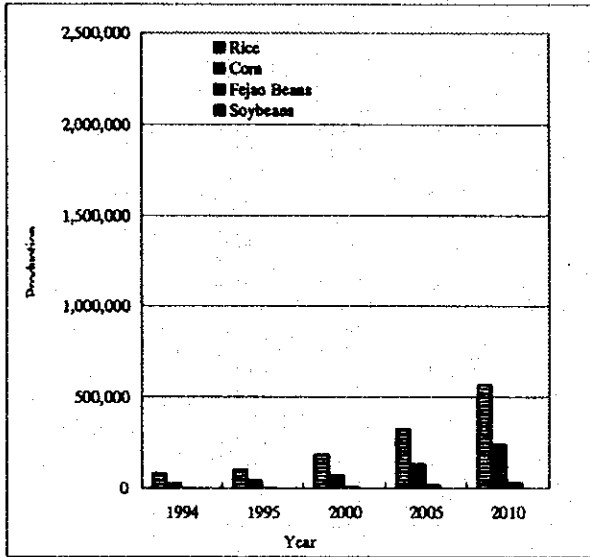
	Unit : ton/year				
	1994	1995	2000	2005	2010
Rice					
Lower Zone	81,737	101,255	185,579	325,693	567,716
Middle Zone	74,526	92,323	169,208	296,959	517,628
Upper Zone	147,380	182,575	334,627	587,271	1,023,673
TOTAL	303,643	376,153	689,414	1,209,923	2,109,017
Corn					
Lower Zone	29,754	41,259	74,006	134,616	240,694
Middle Zone	30,567	42,390	76,036	138,309	247,295
Upper Zone	76,253	105,739	189,665	345,000	616,825
TOTAL	136,574	189,388	339,707	617,925	1,104,814
Feijão Beans					
Lower Zone	3,093	3,748	9,561	17,918	32,919
Middle Zone	3,003	3,641	9,286	17,403	31,972
Upper Zone	7,727	9,370	23,903	44,801	82,309
TOTAL	13,823	16,759	42,750	80,122	147,200
Soybeans					
Upper Zone	10,409	22,840	94,226	234,434	471,516
TOTAL	10,409	22,840	94,226	234,434	471,516

Source : State Secretary of Agriculture, Piauí

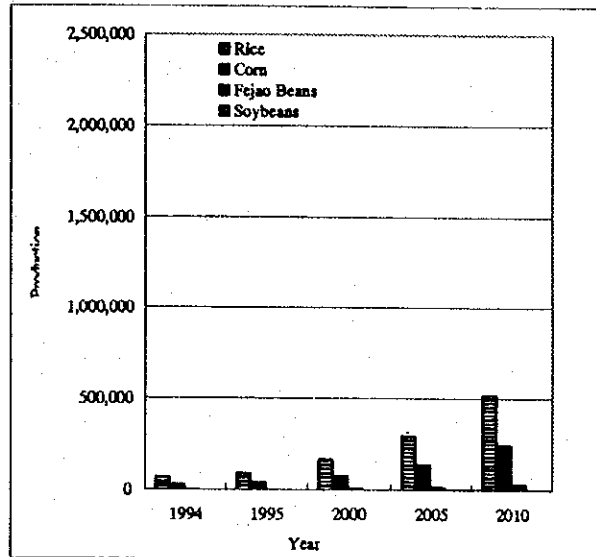


Source : State Secretary of Agriculture, Piauí

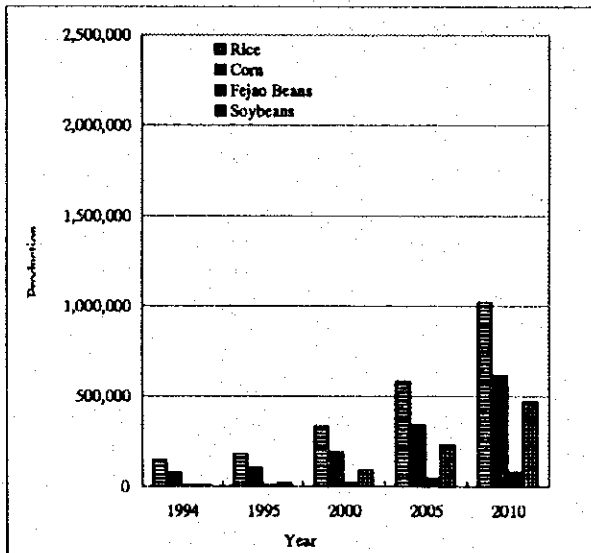
Fig. 5.5.1 Zone Division



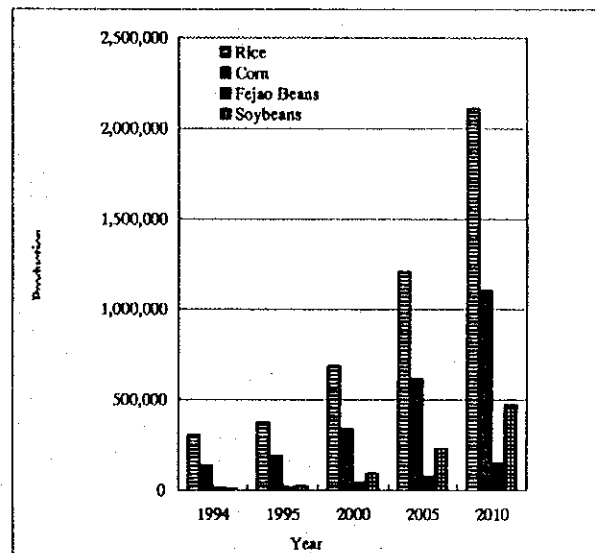
Lower Zone - Estimated Production



Middle Zone - Estimated Production



Upper Zone - Estimated Production



Parnaíba River - Estimated Production Volume

Source : State Secretary of Agriculture, Piauí

Fig. 5.5.2 Estimated Production

Table 5.5.2 Estimated Rice Production Volume in the Parnaíba Basin

PIAUÍ STATE
 AGRICULTURAL PRODUCTION BY MUNICIPALITIES
 INFLUENCED BY THE PARNAÍBA RIVER
 PRODUCT: RICE

	MUNICIPIOS	1994(1)	1995(*)	2000(*)	2005(*)	2010(*)
1	Barras	10,920	13,528	24,794	43,513	75,848
2	Batalha	4,152	5,143	9,426	16,543	28,836
3	Cabeceiras do Piauí	2,060	2,552	4,677	8,208	14,307
4	Esperantina	6,300	7,804	14,303	25,102	43,755
5	Joaquim Pires	3,440	4,261	7,810	13,707	23,893
6	Luzilândia	13,151	16,291	29,858	52,401	91,340
7	Matias Olímpio	2,490	3,085	5,654	9,923	17,297
8	Miguel Alves	2,395	2,967	5,438	9,544	16,636
9	Nossa Sra. dos Remédios	898	1,112	2,038	3,577	6,235
10	Porto	4,484	5,555	10,181	17,868	31,146
11	Buriti dos Lopes	26,717	33,097	60,660	106,458	185,567
12	Parnaíba	4,730	5,860	10,740	18,849	32,856
	SUB-TOTAL	81,737	101,255	185,579	325,693	567,716
13	Altos	5,785	7,166	13,134	23,050	40,178
14	Benedictinos	1,868	2,314	4,241	7,443	12,974
15	Colinas	1,231	1,525	2,795	4,905	8,550
16	Demerval Lobão	1,876	2,324	4,259	7,475	13,030
17	Jose de Freitas	6,552	8,117	14,877	26,109	45,511
18	Miguel Leão	1,173	1,453	2,663	4,674	8,147
19	Monte Santo do Gil	3,270	4,051	7,425	13,031	22,714
20	Lagoa Alegre	925	1,146	2,100	3,686	6,425
21	Teresina	8,141	10,085	18,484	32,439	56,544
22	União	4,040	5,005	9,173	16,099	28,062
23	Agricolândia	2,343	2,903	5,321	9,338	16,277
24	Água Branca	3,680	4,559	8,358	14,665	25,562
25	Amarante	3,807	4,716	8,643	15,168	26,439
26	Angical do Piauí	3,200	3,964	7,265	12,750	22,225
27	Arraial	532	659	1,208	2,120	3,695
28	Barro Duro	2,599	3,220	5,902	10,358	18,055
29	Francisco Ayres	1,675	2,075	3,803	6,674	11,633
30	Hugo Napoleão	2,872	3,558	6,521	11,444	19,948
31	Jardim do Mulato	1,659	2,055	3,766	6,609	11,520
32	Palmeiras	3,230	4,001	7,333	12,869	22,432
33	Passagem Franca do Pi.	2,566	3,179	5,826	10,225	17,823
34	Regeneração	3,962	4,908	8,995	15,786	27,517
35	São Gonçalo do Pi.	960	1,189	2,179	3,824	6,666
36	São Pedro do Piauí	6,580	8,151	14,939	26,218	45,701
	SUB-TOTAL	74,526	92,323	169,208	296,959	517,628
37	Baixa Grande do Ribeiro	34,263	42,445	77,793	136,527	237,980
38	Ribeiro Gonçalves	8,715	10,796	19,787	34,726	60,531
39	Santa Filomena	7,266	9,001	16,497	28,952	50,466
40	Urucui	25,150	31,156	57,103	100,218	174,887
41	Antonio Almeida	8,315	10,301	18,880	33,134	57,756
42	Bertolínea	11,600	14,370	26,337	46,221	80,568
43	Colônia do Gurgueia	1,150	1,425	2,612	4,584	7,990
44	Eliseu Martins	714	885	1,622	2,847	4,963
45	Landri Sales	2,000	2,478	4,542	7,971	13,894
46	Manoel Emídio	9,000	11,149	20,434	35,862	62,511
47	Marcos Parente	648	803	1,472	2,583	4,502
48	Canavieira	1,121	1,389	2,546	4,468	7,788
49	Flores do Piauí	1,860	2,304	4,223	7,411	12,918
50	Floriano	1,483	1,837	3,367	5,909	10,300
51	Guadalupe	1,119	1,386	2,540	4,458	7,771
52	Itaueira	3,660	4,534	8,310	14,584	25,421
53	Jurumenha	686	850	1,558	2,734	4,766
54	Nazare do Piauí	3,496	4,331	7,938	13,931	24,293
55	Rio Grande do Piauí	1,560	1,933	3,543	6,218	10,839
56	São Francisco do Piauí	847	1,049	1,923	3,375	5,883
57	São José de Peixe	1,025	1,270	2,328	4,086	7,122
58	Barra das Flores	1,013	1,255	2,300	4,037	7,037
59	Bom Jesus	2,300	2,849	5,222	9,165	15,976
60	Cristino Castro	1,671	2,070	3,794	6,658	11,606
61	Gilbués	3,680	4,559	8,356	14,665	25,563
62	Monte Alegre do Piauí	6,720	8,325	15,258	26,778	46,677
63	Palmeira do Piauí	806	998	1,829	3,210	5,595
64	Redenção do Gurgueia	1,480	1,833	3,360	5,897	10,279
65	Santa Luz	1,296	1,605	2,942	5,163	9,000
66	Corrente	2,052	2,542	4,659	8,177	14,253
67	Cristalândia do Piauí	684	847	1,552	2,724	4,748
	SUB-TOTAL	147,380	182,575	334,627	587,271	1,023,673
	TOTAL	303,643	378,153	689,414	1,209,923	2,109,017

(1) AGRICULTURAL PRODUCTION SYSTEMATIC SURVEY, 1994

(*) PROJECTED FOR 1995, 2000, 2005 AND 2010

Table 5.5.3 Estimated Feijão Beans Production Volume in the Parnaíba Basin

PIAUI STATE
 AGRICULTURAL PRODUCTION BY MUNICIPALITIES
 INFLUENCED BY THE PARNAÍBA RIVER
 PRODUCT: BEANS

		Unit: (t)				
	MUNICIPIOS	1994(1)	1995(*)	2000(*)	2005(*)	2010(*)
1	Barras	480	582	1,485	2,783	5,113
2	Batalha	135	164	418	783	1,439
3	Cabeceiras do Piauí	67	81	207	398	713
4	Esperantina	110	133	339	635	1,167
5	Joaquim Pires	220	267	681	1,276	2,344
6	Luzilândia	1,071	1,298	3,311	6,206	11,402
7	Metesópolis	106	128	327	613	1,126
8	Miguel Alves	372	451	1,150	2,155	3,959
9	Nossa Sra. dos Remédios	21	25	64	120	220
10	Porto	54	65	166	311	571
11	Buriti dos Lopes	313	379	967	1,812	3,329
12	Parnaíba	144	175	446	836	1,536
SUB-TOTAL		3,093	3,748	9,581	17,918	32,919
13	Altos	354	429	1,094	2,050	3,766
14	Benedictinos	76	92	235	440	808
15	Coivaras	74	90	230	431	792
16	Demerval Lobão	14	17	43	81	149
17	Jose de Freitas	323	392	1,000	1,874	3,443
18	Miguel Leão	249	302	770	1,443	2,651
19	Monte Alegre	36	44	112	210	386
20	Lagoa Alegre	40	48	122	229	421
21	Teresina	247	299	763	1,430	2,627
22	União	400	485	1,237	2,319	4,260
23	Agricolândia	56	68	173	324	595
24	Agua Branca	113	137	349	654	1,202
25	Amarante	186	225	574	1,076	1,977
26	Angical do Piauí	29	35	89	167	307
27	Arraial	90	109	278	521	957
28	Berro Duro	110	133	339	635	1,167
29	Francisco Ayres	130	158	403	755	1,387
30	Hugo Napoleão	66	80	204	382	702
31	Jardim do Mulato	50	61	156	292	536
32	Palmeiras	28	34	87	163	299
33	Passagem Franca do Pi.	121	147	375	703	1,292
34	Regeneração	31	38	97	182	334
35	São Gonçalo do Pi.	28	34	87	163	299
36	São Pedro do Piauí	152	184	469	879	1,615
SUB-TOTAL		3,003	3,841	9,286	17,403	31,972
37	Baixa Grande do Ribeiro	436	528	1,347	2,525	4,639
38	Ribeiro Gonçalves	215	261	666	1,248	2,293
39	Santa Filomena	24	29	74	139	255
40	Uruçuí	96	116	296	555	1,020
41	Antonio Almeida	1,079	1,308	3,336	6,253	11,488
42	Bertolínea	252	305	778	1,458	2,679
43	Colônia do Gurgueia	263	319	814	1,526	2,804
44	Eliseu Martins	152	184	469	879	1,615
45	Landri Sales	201	244	622	1,166	2,142
46	Manoel Emídio	100	121	309	579	1,064
47	Marcos Parente	80	97	247	463	851
48	Canavieira	14	17	43	81	149
49	Flores do Piauí	265	321	819	1,535	2,820
50	Floriano	300	364	928	1,739	3,195
51	Guadalupe	92	116	296	555	1,020
52	Itaueira	610	739	1,885	3,533	6,491
53	Jurumenha	4	5	13	24	44
54	Nazare do Piauí	164	199	508	952	1,749
55	Rio Grande do Piauí	305	370	944	1,769	3,250
56	São Francisco do Piauí	91	110	281	527	968
57	São José de Peixe	124	150	383	718	1,319
58	Barreiras do Piauí	58	70	179	335	615
59	Bom Jesus	296	359	916	1,717	3,154
60	Cristino Castro	1,154	1,399	3,569	6,689	12,289
61	Gibúes	113	137	349	654	1,202
62	Monte Alegre do Piauí	103	125	319	598	1,099
63	Palmeira do Piauí	199	241	615	1,153	2,118
64	Redenção do Gurgueia	169	205	523	980	1,800
65	Santa Luz	192	233	594	1,113	2,045
66	Corrente	280	339	865	1,621	2,978
67	Cristalândia do Piauí	296	359	916	1,717	3,154
SUB-TOTAL		7,727	9,370	23,903	44,801	82,309
TOTAL		13,823	16,759	42,750	80,122	147,200

(1) AGRICULTURAL PRODUCTION SYSTEMATIC SURVEY, 1994
 (*) PROJECTED FOR 1995, 2000, 2005 AND 2010

Table 5.5.4 Estimated Corn Production Volume in the Parnaíba Basin

PIAUI STATE
 AGRICULTURAL PRODUCTION BY MUNICIPALITIES
 INFLUENCED BY THE PARNAÍBA RIVER
 PRODUCT: CORN

		Unit: (t)				
	MUNICIPIOS	1994(1)	1995(*)	2000(*)	2005(*)	2010(*)
1	Barras	4,860	6,739	12,088	21,988	39,315
2	Batalha	3,600	4,992	8,954	16,287	29,121
3	Cabeceiras do Piauí	1,185	1,643	2,947	5,361	9,585
4	Esperantina	3,722	5,161	9,257	16,838	30,106
5	Joaquim Pires	1,920	2,662	4,775	8,688	15,531
6	Luziândia	5,645	7,828	14,041	25,540	45,666
7	Matias Olímpio	1,716	2,380	4,269	7,765	13,884
8	Miguel Alves	1,848	2,583	4,597	8,562	14,951
9	Nossa Sra. dos Remédios	632	876	1,571	2,858	5,110
10	Porto	1,008	1,398	2,508	4,562	8,157
11	Buritil dos Lopes	2,666	3,697	6,631	12,062	21,567
12	Parnaíba	952	1,320	2,368	4,307	7,701
SUB-TOTAL		29,754	41,259	74,006	134,616	240,694
13	Altos	3,270	4,535	8,134	14,796	26,455
14	Benedictinos	1,785	2,475	4,439	8,075	14,438
15	Coivaras	302	419	752	1,368	2,446
16	Demerval Lobão	539	747	1,340	2,437	4,357
17	Jose de Freitas	3,870	5,367	9,627	17,512	31,311
18	Miguel Leão	780	1,082	1,941	3,531	6,313
19	Monsenhor Gil	2,103	2,916	5,230	9,513	17,009
20	Lagoa Alegre	441	612	1,098	1,997	3,571
21	Teresina	2,622	3,636	6,522	11,664	21,213
22	União	2,340	3,245	5,821	10,588	18,931
23	Agricolândia	993	1,377	2,470	4,493	8,033
24	Água Branca	1,740	2,413	4,328	7,873	14,077
25	Amarante	563	781	1,401	2,548	4,556
26	Angical do Piauí	938	1,301	2,334	4,246	7,592
27	Arraial	746	1,034	1,855	3,374	6,033
28	Barro Duro	780	1,082	1,941	3,531	6,313
29	Francisco Ayres	982	1,362	2,443	4,444	7,946
30	Hugo Napoleão	594	824	1,478	2,688	4,808
31	Jardim do Mulato	488	677	1,214	2,208	3,948
32	Palmeiras	1,332	1,847	3,313	6,026	10,774
33	Passagem Franca do Pi.	788	1,093	1,961	3,567	6,378
34	Regeneração	688	954	1,711	3,112	5,564
35	São Gonçalo do Pi.	308	427	786	1,393	2,491
36	São Pedro do Piauí	1,575	2,184	3,917	7,125	12,740
SUB-TOTAL		30,567	42,390	76,036	138,309	247,295
37	Baixa Grande do Ribeiro	1,812	2,513	4,508	8,200	14,662
38	Ribeiro Gonçalves	951	1,319	2,366	4,304	7,896
39	Santa Filomena	1,894	2,626	4,710	8,567	15,318
40	Urucui	2,102	2,915	5,229	9,512	17,007
41	Antonio Almeida	1,902	2,638	4,732	8,608	15,391
42	Bertolínea	1,100	1,525	2,735	4,975	8,895
43	Colônia do Gurgelá	870	1,206	2,163	3,934	7,034
44	Elséu Martins	762	1,057	1,896	3,449	6,167
45	Lândri Sales	464	643	1,153	2,097	3,749
46	Manoel Emídio	1,792	2,485	4,457	8,107	14,495
47	Marcos Parente	504	699	1,254	2,281	4,078
48	Canavieira	1,567	2,173	3,898	7,090	12,677
49	Flores do Piauí	4,600	6,379	11,442	20,813	37,214
50	Floriano	2,071	2,872	5,152	9,371	16,755
51	Guadalupe	205	284	509	926	1,656
52	Itaueira	24,360	33,780	60,591	110,215	197,064
53	Jurumenha	216	300	538	979	1,750
54	Nazare do Piauí	1,144	1,586	2,845	5,175	9,221
55	Rio Grande do Piauí	13,300	18,443	33,081	60,174	107,591
56	São Francisco do Piauí	1,322	1,833	3,288	5,981	10,694
57	São José de Peixe	2,040	2,829	5,074	9,230	16,503
58	Barreiras do Piauí	207	287	515	937	1,675
59	Bom Jesus	1,430	1,983	3,557	6,470	11,568
60	Cristino Castro	1,480	2,052	3,681	6,696	11,972
61	Gilbués	288	399	716	1,302	2,328
62	Monte Alegre do Piauí	462	641	1,150	2,092	3,740
63	Palmeira do Piauí	975	1,352	2,425	4,411	7,887
64	Redenção do Gurgueia	875	1,213	2,176	3,958	7,077
65	Santa Luz	2,940	4,077	7,313	13,302	23,784
66	Corrente	1,860	2,579	4,626	8,415	15,046
67	Cristalândia do Piauí	758	1,051	1,885	3,429	6,131
SUB-TOTAL		76,253	105,739	189,665	345,000	616,825
TOTAL		136,574	189,388	339,707	617,925	1,104,814

(1) AGRICULTURAL PRODUCTION SYSTEMATIC SURVEY, 1994

(*) PROJECTED FOR 1995, 2000, 2005 AND 2010

Table 5.5.5 Estimated Soybeans Production Volume in the Parnaíba Basin

PIAU STATE
 AGRICULTURAL PRODUCTION BY MUNICIPALITIES
 INFLUENCED BY THE PARNAÍBA RIVER
 PRODUCT: SOY BEANS

		Unit: (t)				
	MUNICIPIOS	1994(1)	1995(*)	2000(*)	2005(*)	2010(*)
1	Baixa Grande do Ribeiro	2,738	6,008	24,786	61,668	124,033
2	Santa Filomena	150	329	1,357	3,376	6,790
3	Urucui	6,588	14,457	59,642	148,389	298,455
4	Bertolínea	450	987	4,072	10,131	20,376
5	Landri Sales	33	72	297	739	1,486
6	Monte Alegre do Piauí	450	987	4,072	10,131	20,376
TOTAL		10,409	22,840	94,226	234,434	471,516

(1) AGRICULTURAL PRODUCTION SYSTEMATIC SURVEY, 1994

(*) PROJECTED FOR 1995, 2000, 2005 AND 2010

- | | |
|--------------------------------|-----------------------------|
| 01. Barras | 37. Baixa Grande do Ribeiro |
| 02. Batalha | 38. Ribeirão Gonçalves |
| 03. Cabeceiras do Piauí | 39. Santa Filomena |
| 04. Esperantina | 40. Uruçuí |
| 05. Joaquim Pires | 41. Antônio Almeida |
| 06. Luzilândia | 42. Bertolínia |
| 07. Matias Olímpio | 43. Colônia do Gurgueia |
| 08. Miguel Alves | 44. Eliseu Martins |
| 09. Nossa Senhora dos Remédios | 45. Landri Sales |
| 10. Porto | 46. Manoel Eudó |
| 11. Buriti dos Lopes | 47. Marcos Parente |
| 12. Parnaíba | 48. Canaveira |
| 13. Altos | 49. Flores do Piauí |
| 14. Beneditinos | 50. Floriano |
| 15. Demerval Lobão | 51. Guadalupe |
| 16. José de Freitas | 52. Itauera |
| 17. Miguel Leão | 53. Jerumenha |
| 18. Monsenhor Gil | 54. Nazaré do Piauí |
| 19. Lagoa Alegre | 55. Rio Grande do Piauí |
| 20. Teresina | 56. São Francisco do Piauí |
| 21. União | 57. São José do Peixe |
| 22. Colvaras | 58. Barreiras do Piauí |
| 23. Agricolândia | 59. Bom Jesus |
| 24. Água Branca | 60. Cristiano Castro |
| 25. Amarante | 61. Gilbués |
| 26. Angical do Piauí | 62. Monte Alegre do Piauí |
| 27. Arraial | 63. Palmeira do Piauí |
| 28. Barro Duro | 64. Redenção do Gurgueia |
| 29. Francisco Alves | 65. Santa Luz |
| 30. Hugo Napoleão | 66. Corrente |
| 31. Jardim do Muleto | 67. Cristalândia do Piauí |
| 32. Palmeira | |
| 33. Passagem Franca do Piauí | |
| 34. Regeneração | |
| 35. São Gonçalo do Piauí | |
| 36. São Pedro do Piauí | |

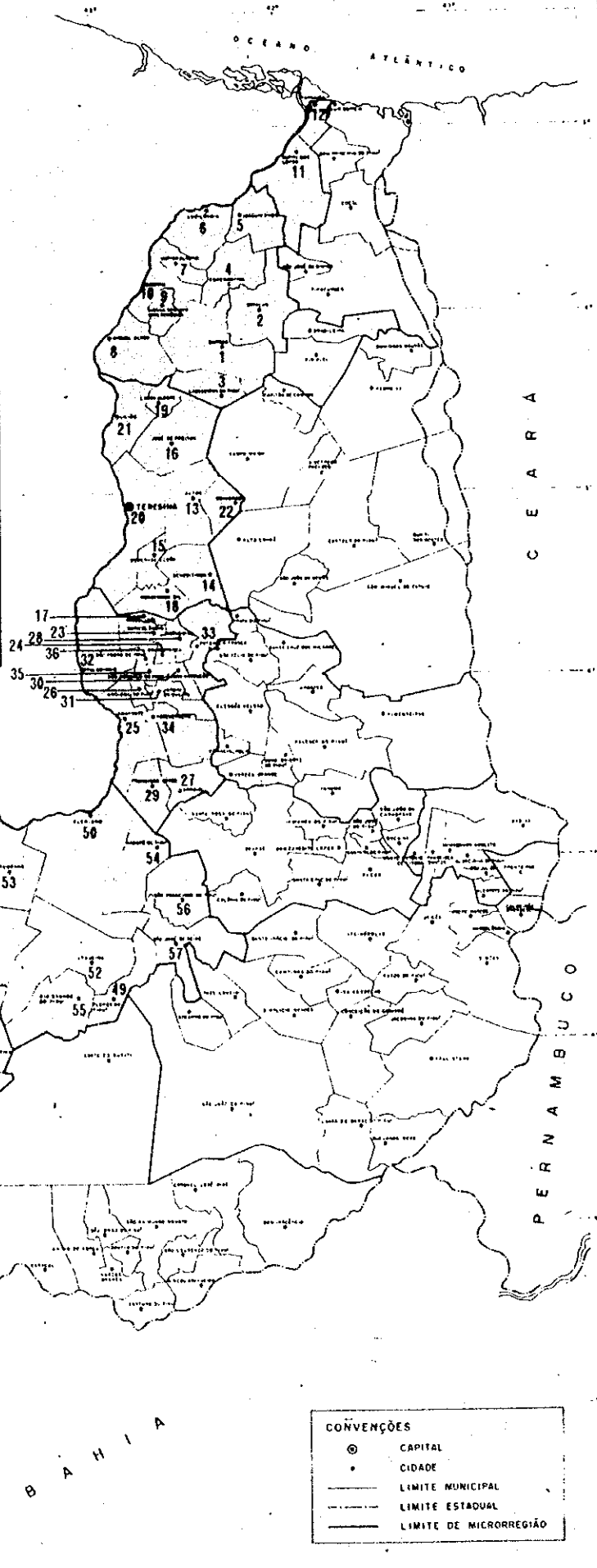


Fig. 5.5.3 Related Area Map for the Agricultural Production